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THE MINERALOGICAL SOCIETY

Mineralogical Society of Great Britain & Ireland

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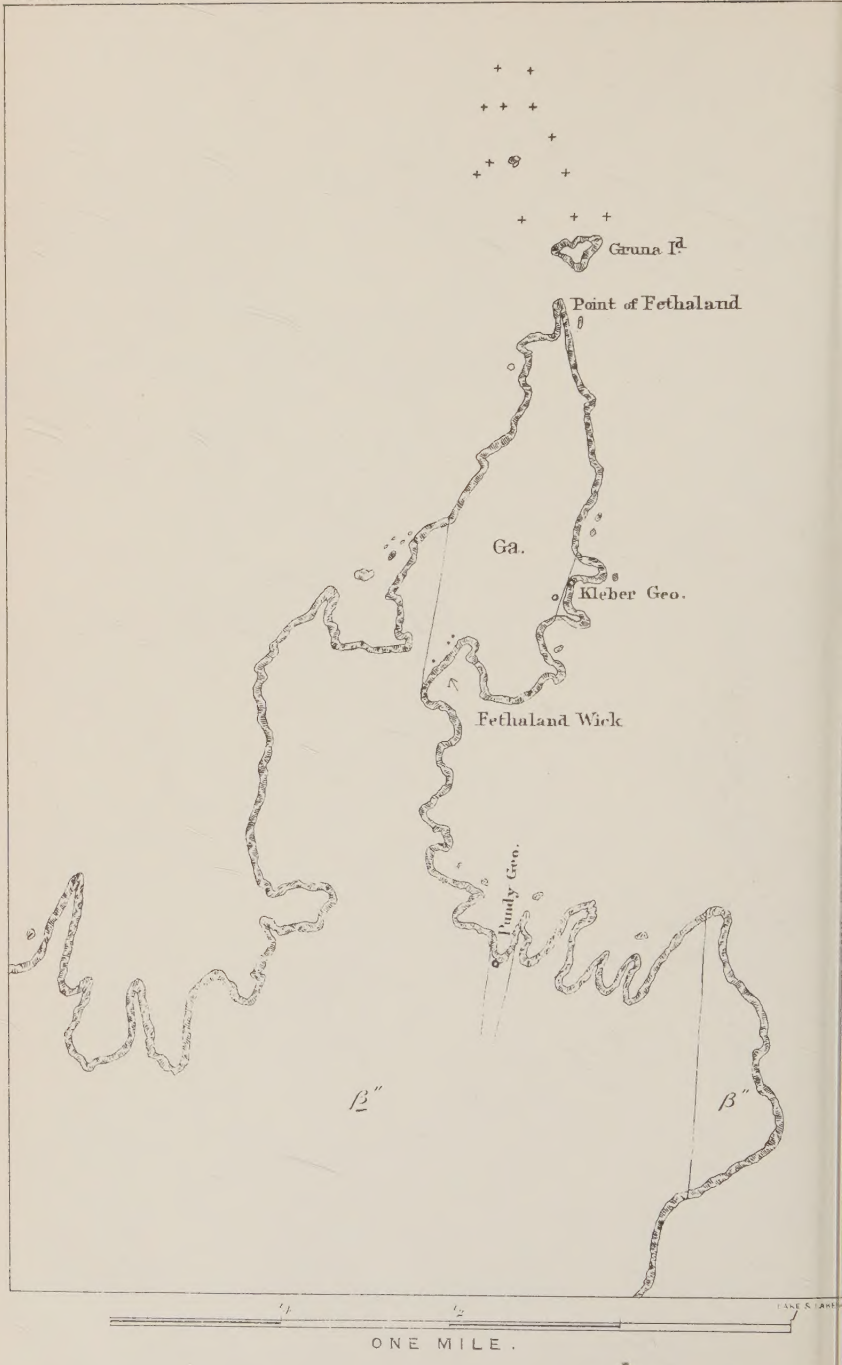

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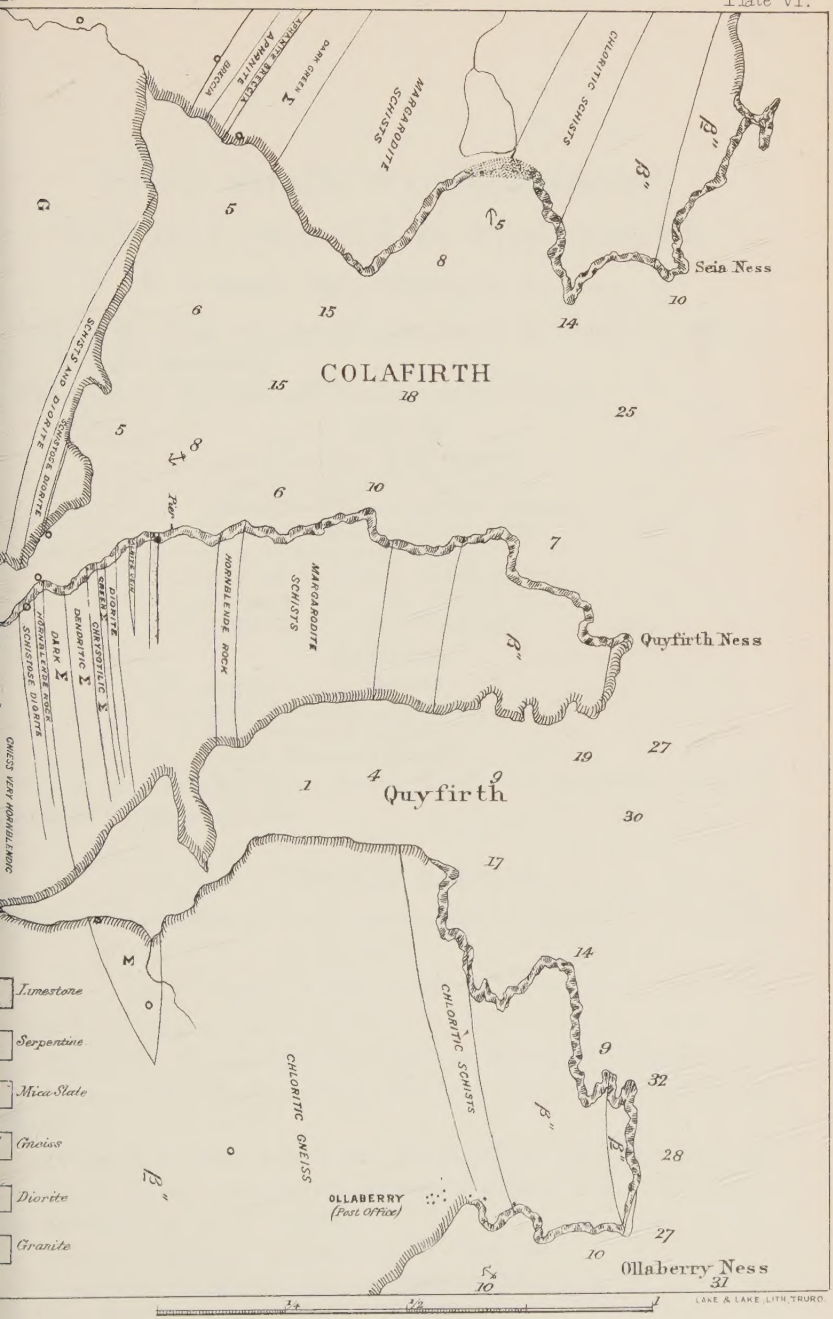

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EXCERPT MINUTES OF COUNCIL MEETING.

Held at 116, *Victoria Street, London, W., January 7th*, 1879.

H. C. Sorby, F.R.S., President, in the Chair.

Prof. A. H. Green was elected a Member of the Council in place of Prof. Harkness (deceased).

The following Members and Associates were elected:—

MEMBERS.

Thomas Aitken, M.D., Inverness.
John Horne, F.G.S., Edinburgh.
Professor Gustave Uzielli, Modena.
M. Guyot (de Grandmaison), Paris.
Rev. J. Finnemore, Truro.
Rev. W. W. Peyton, Broughty Ferry.
Josiah T. Smith, Barrow-in-Furness.
John Gibson, Ph.D., Edinburgh.

ASSOCIATES.

Samuel Jones, Swansea.
John Ede Drew, Penzance,
John Crocker, Redruth.
Frank Johnson, Redruth.

It was unanimously resolved that the number of corresponding members should be for the present 24.

GENERAL MEETING.

Held according to Notice at 116, *Victoria Street, London, W., January 7th*, 1879.

H. C. Sorby, F.R.S., President, in the Chair.

The following papers were read:—

"On Pilolite, an unrecognised species," by Prof. M. F. Heddle.

"On so-called 'Green Garnets' from the Urals," by Prof. A. H. Church.

"On the Magnetism of Rocks and Minerals," by J. B. Hannay, F.C.S.

"On the Celestine and Baryto-celestine of Clifton," by J. N. Collie, communicated by W. W. Stoddart, F.G.S.

"On some Silicates of Copper," by W. Semmons.

"Contributions towards a history of British Meteorites," by Townshend M. Hall, F.G.S.

"Notes on some Crystals of Iron," by Amos Beardsley, F.G.S.

"On massive and crystallized Cronstedtite," by A. K. Barnett, F.G.S.

Specimens in illustrations of their papers were exhibited by Messrs. Beardsley, Collie, and Barnett.

Capt. Dowler, a visitor, exhibited specimens of the "green garnets" of the Urals, in the matrix.

Mr. J. R. Gregory exhibited specimens as follows :—

Meteorite (part of) which fell Oct. 13, 1877, at 2 p.m., at Soko Banja, N.E. of Alexinatz, near Belgrade, Servia, weight 2 lbs.

Meteoric Iron from Santa Caterina, Brazil, found by Manuel Goncalves Da Rosa, in 1875, weight 14 lbs. This forms part of a mass of which 20,000 kilograms were smelted as an ore of nickel, which it was at first thought to be.

BOOKS RECEIVED.

From *Prof. J. D. Dana, Newhaven.*
American Journal of Science, Nov., 1878, to Jan., 1879.

From *Prof. Groth, Strasburg.*
Zeitschrift fur Kryst. und Min., Band 3, Heft 1.

From *Reale Comitato Geologico, Rome.*
Bolletino 9 to 12, 1878.

From *Soc. Geol. de Belgique, Liége.*
Annales t. 2, 3, and 4.

From *Royal Society of New South Wales, Sydney.*
Journal and Proceedings, vol. xi, 1877.
The Railways of New South Wales.

From *Prof. Haughton, F.R.S , Dublin.*
The Mineralogy of Counties Dublin and Wicklow.

From *Prof. Gustave Uzielli, Modena.*
Sopra la Titanite a l' Apatite della Lama dello Spedalaccio.
Sulle striæ di dissoluzione dell' Allume potassico di Cromo.
Nota sopra lo Zircone della Costa Tirrena.
Studi di cristallografia teorica.
Sopra la Mancinite.

From *Mr. R. H. Scott, F.R.S., London.*
La Bárcenita, by Dr. J. W. Mallet.

From *M. Emile Bertrand, Paris.*
Note sur la forme cristalline de la Friedelite.

From *Mr. T. W. Danby, Ipswich.*
The Determination of Minerals by the blowpipe, by Dr. C. W. C. Fuchs, translated by T. W. Danby.

From *Prof. T. Rupert Jones, F.R.S., Yorktown.*
Notes on Crystallography and Crystallophysics, by John Milne.

SPECIMENS RECEIVED.

Three octahedral crystals of iron from the interior of a pig of that metal, by Amos Beardsley, F.G.S.

Specimens of baryto-celestine from Clifton, by J. N. Collie.

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MINERALOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

No. 11. DECEMBER, 1878. Vol. II.

XV.—*The Geognosy and Mineralogy of Scotland.*

By Professor Heddle.

THE MAINLAND.

Anyone who contemplates on a map the great size of this island in geographic extension, and its extraordinarily irregular outline, would conclude that it must be composed of various formations, and that the connections and dispositions of these must be intricate in the extreme.

The latter conclusion will, however, upon a more careful observation, be found to apply only to the western portion of the island. However deeply trenched by the sea in its lower grounds, however persistently thrusting its cliffs oceanward in its higher, the ridged and furrowed outlines of the eastern, disposed in almost rectilinear sequence, indicate but one formation,—various as the members of that formation may in mere lithological features appear.

Two depressions of nearly equal magnitude and depth,—Bigsetter and Soulam Voes,—separate this eastern section geologically and almost geographically from the second. This western division is as intricate in its geology, as it is peculiar in outlines.

Deferring minuter details to the consideration of the more interesting spots, the main features of these two natural divisions may be meanwhile glanced at.

If we except a series of strata of Old Red Sandstone age,* which, with a general south-easterly dip, lie unconformably upon the subjacent rocks, the whole of the eastern section of this island will be found to consist of

rocks of a highly metamorphic character, and, in the main, of one general type.

Underlying a conglomerate of the "Old Red,"—here loose in structure, granular, granitic, and sprinkled largely with "chloritic," or perchance glauconitic dust,—there occur thin beds of chloritic-schist, which are succeeded by much more persistent and uniformly spread strata of argillaceous-schist. These rocks have a general dip to the west, and, as they are overlaid in regular ascending series westward, they form the lowest visible member of the whole stratified rocks of Shetland.

These clay slates form the greater mass of a prolonged tongue of land which, for twenty miles, stretches southward from the main bulk of the island.

The western coast of this stretch of country is skirted, though not continuously, by thinner beds of a hornblendic schist, which carries much felspar, and which, in the southerly districts, is to a large extent replaced by quartzoze strata; the hornblendic rock is well seen in the south at St. Ronan's island, and in the north at Hawksness.

These rocks, being of a harder and more enduring nature than the clay slate, may have proved in great measure the barrier which has repelled the inroads of the western sea; though a still more westerly band of a granitic rock, which forms the line of demarkation between the two great divisions of its strata, doubtless had, for long, performed that function.

This granitic band or dyke cuts off the peculiar slates of the Fitfiel Head (already described in the chapter on Unst) from those of the Cliff Hills,—raises the ruins only of its former course above the waters in a line of islets in the bay of Scalloway,—courses up the trough between Bigsetter and Magnusetter Voes, and possibly is continued in ampler development in the mass of igneous rock which forms the coast, and the islands which break the surface of the Sound of Yell. To this rock Hibbert has assigned the name of epidotic syenite. At its southern extremity it does contain some small quantity of epidote, and grains of the same mineral may be seen in it, where it becomes porphyritic, as in the neighbourhood of Bigsetter Voe: but throughout the larger mass of the rock as seen at Yell Sound the constituents appear to be solely minute dark-green crystals of hornblende and albite. As it approaches the granite of the Roc district,

* East of Lerwick a quarry of dark-grey flagstones, which are profusely sprinkled with mica, contains a peculiar calamite-like organism of sometimes a couple of feet in length; this has a bulbous dilatation with apparently rootlets. Specimens of small fishes, apparently acanthoides, were shown the writer; these were imbedded in a brown fine-grained muddy sandstone; they were stated to occur in a quarry north of Gardie, in Bressay.

orthoclase and quartz are superadded, and though the rock retains its markedly crypto-crystalline character it can now be regarded as merely a very hornblendic granite.

Of this south-eastern or clay-slate portion of the mainland it need, in the present connection, only be said that its strata are at their northern limits deflected eastward from their usual S. by W. and W. by E. strike Here also there is a departure from the simplicity of their structure in this, that to the west of Rovie Head, and between the clay slates and the conglomerate, there is intercalated a bed of limestone which curves round to to reappear in the Greenholm, and the dangerous rocks called the Brethern; and, that on the western shore of Deals Voe two successive strata of hornblendic schist, similar to the limiting one already noticed, are to be seen. Thin beds of limestone also occur here.

The ground lying between the westerly hornblendic rock and the granite is occupied by frequent alternations of strata, usually more immediately included under the term of gneissic rocks. Of these, many varieties as regards presence, absence, and relative proportion of the felspathic or micaceous ingredient of such rocks, are to be seen; but they may be divided into four great belts both in virtue of inherent lithological differences and to a great extent by an actual partition being effected by three great bands or series of compound bands of limestone.

In fact, one great feature of the gneisses of Shetland, as a whole, is the manner in which they are pervaded with interstrata of limestone.

The most easterly of the three larger belts of limestone is, in the Island of Tronda, in actual contact with the hornblendic rock to the east; and is also to a certain extent interstratified with those portions of the same rock which occur to the west of the Cliff Hills. It is like most of the others of a pale blue colour, a fine granular structure which is somewhat obscure, and it is very frequently schistose from interlaminated margarodite.

This bed courses up the Vale of Tingwall, still in contact with the hornblende rock, and thins off towards the Head of Catfirth Voe.

According to Hibbert, the lime of Laxfirth and of Eswick are offsets which can be traced to a junction with this.

To this limestone, the first of the four divisions which go to form the central gneiss of Shetland succeeds. It may be defined as the typical gneiss of the islands,—somewhat more schistose, less frequently contorted, and paler in colour than the gneisses of the mainland of Scotland. It is very rarely diversified in appearance; hardly ever carries even garnet, occasionally hornblende in small particles, and altogether is most barren of

minerals. Its prevailing strike is that of the Cliff Hills, that also of most of the schistose rocks—from a little W. of S. to a little E. of N.

The second, a less important series of beds of lime, commences in the south at Ustaness, sinks into the head of Stromness Voe, and probably forms the beds of the lakes north thereof.

This bed is succeeded by the only gneiss which I have seen in Shetland which contains a dark mica; this, in too small particles to be recognizable, is in but small amount after all, for the beds here are unusually quartzose, little felspar even being visible. This rock may be seen from Bennyness up the greater part of the east shore of Weesdale Voe; but I do not know that it continues up the country; it should come out of the heather and bog at the head of Olnafirth; but the shore is there concealed by sand.

These quartzose beds are overlaid by the largest mass of limestone in Shetland.

This is first visible in the south in a cluster of islands in Weesdale Voe; as the sea loch gradually narrows it appears on both of its shores, being here, with interstrata of schists, probably half a mile in width. It diminishes from this width considerably as it courses northward, until it is lost in a bifurcation in the peninsula of Foraness at the mouth of Deals Voe, after a course of nearly twenty miles.

Westward of the lime there occurs a series of strata chiefly of mica-slate; these follow the limestone throughout, but contain no interbedded strata thereof. This is the longest ridge of highly elevated land in Shetland; its altitude seldom falls, and it contains the four elevations of Weesdale Hill, 842 feet; Scallafield, 916; Snuggie Hill, and The Leas of Deal, 820;—it has received the name of the Western Kame.

West of this the strata are again normally gneissic, felspar being here in excess; granitic and quartzose veins also interlace the beds, and both limestone and hornblende are seen where, at their northern extremity, they approach the granite of Olnafirth.

In crossing this extensive system of rocks from east to west it is observed that the interstrata of hornblende diminish in bulk and in frequency until the granitic rock is approached, when hornblende makes its appearance to a small extent, in a state of diffusion throughout the mass of the adjacent strata.

These strata are as a whole wonderfully continuous and rectilinear in their strike.

Subject merely to local variations in the angle, the whole system dips to the west, with a prevailing inclination of about 40°.

To the north there is less of regularity in the series; there being here noticeable a general sweeping of the outcrops towards the east. As the rectilinear course is again taken up in the Island of Yell, this is doubtless due to their being impinged upon by the granitic mass to the north west, and to the continuity of their course being partially broken in upon by eruptive rock, both at west and east, namely at Olnafirth and Lax Voe.

Nowhere else perhaps in Scotland is it made so manifest that a series of diverse rocks, varying so markedly from soft to hard, from friable to enduring, from light in colour to sombre from their blackness, form but members of one system, differing in the individuality of their composition, but agreeing in the circumstances of their formation, and as to the agencies concerned in the transmutation which they have undergone.

The uniformity of their strike and dip,—the occurrence of intercalations of limestone (indistinguishable in their characters) amongst the diverse members, and of hornblendic strata indiscriminately throughout the whole, can lead to no other inference. These features are here more noticeable than any direct merging of the several rocks into that member which may be adjacent. The individualising of the various members of a series may be called for elsewhere in Scotland, and is not altogether without its advantages even elsewhere in Shetland, but it is little more than a mere convenience here. Here, also, and elsewhere in Shetland, we are taught that however advantageous and applicable as a distinctive term such a name as hornblendic gneiss may be elsewhere, it is often a mere mineralogical variety; and while the hornblendic rock of the lower gneiss (Laurentian) has features quite distinct from those of any rock *in this district*, a rock entitled to the name of hornblendic gneiss cannot of itself be a mark of distinction between two great formations; though doubtless any great prevalence of that rock may come to be so.

The only other observations I shall make on this general series pertain to its limestones: these, of blue and yellow tints, and distinctly metamorphic, form, as a rule, the valleys, through disintegration and solution; and open up the rocks to the ingress of the sea. The north and west Voes of Dale and Weesdale, and of Laxfirth and Scalloway, with the intervening troughs, are excellent types of this. But there is a notable exception; limestone forms the enduring backbone of the lengthened ridge which separates Whitehouse from Stromness Voes.*

The larger interstrata of these limestones separate the more distinctive masses of the rocks: the smaller are mostly associated with the hornblendic belts.

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* Time did not suffice for my endeavouring to attain to the cause of this anomalous endurance.

But the marked peculiarity of the limestones altogether, is the absence of simple minerals either in their mass, or at the lines of their contact with the adjacent rocks. These most fruitful situations elsewhere in Scotland, are here altogether barren, this,—their feeble metamorphism and the small amount of folding in their beds, are everywhere observable; the latter indeed forms a distinctive feature of the Shetland schists.

If in this eastern portion of the Mainland of Shetland we have simplicity and regularity, in the western we have complexity and confusion.

Two triangular wing-like appendages, attached to the portion described, form the geographical configuration of this section; but the structure of these outlying portions is very dissimilar.

In both, granitic rocks occur, producing marked disturbance.

Holding firmly to the view which regards much of the granite of Scotland as the completion of the metamorphism of gneiss, I am unable to adopt for a moment any such view as regards the granite of Shetland. The nature of the rock itself, the abutments of the stratified rocks against its flanks, and the disturbances it has produced among their adjacent layers, forbid such a view.

In both of the triangularly shaped districts, igneous rocks have found some portions of gneiss to break in upon, disrupt, separate, and mangle. And this has been so thoroughly accomplished that in the northern triangle only a few fragments are visible, no one of which retains the normal strike and dip.

In the southern triangle, granite, which is found here in much smaller quantity, has been merely driven like a wedge between the gneiss of the eastern division and a series of quartzose beds;—these are red in the west, blue in the east.

The strike of these quartzose districts is quite different from that of the gneissose rocks; having a bearing which lies nearly at right angles to those of the east.

I had only opportunities of observing them for a few miles N.W. of Veila Sound, and in one or two spots at the head of Voes on the north-west coast. Without wishing to question Hibbert's conclusion that they are entitled to the name of quartzite, I have to say that in some places I observed them to be very flaggy and micaceous, that they seemed to contain organic or at least carbonaceous matter, and that they have an appearance much more recent than that of the eastern and western rocks.

I had unfortunately no opportunity of satisfactorily examining the connections of the *red* western beds, on either side. Those near the village of Dale seem to be separated from the grey eastern beds by a great porphyry

dyke which runs up the country, but from the shelving and covered nature of the ground it is not easy to determine that it may not be an interbedded mass.

This "red quartzite" when examined in hand specimens gathered at Snarra Voe cannot be distinguished from the red Cambrian sandstones of the summit of Teallick in Ross, or from those of the north of Rum.

To the west of both of these triangular appendages, volcanic rocks of Old Red Sandstone, and perchance still more recent date, appear; these will be noticed in their places in the description of special localities.

These conveniently may succeed each other from north to south.

POINT OF FETHALAND.

The geology here is very simple.

Along the line forming the south boundary of the mass, gneiss is to be found; this, by the almost entire loss of its felspar, a marked increase in the size of its plates of mica, and the very occasional addition of crystals of garnet, assumes, on the east coast, the characters of a coarse-grained mica-slate.

The little peninsula of Fethaland is formed for the most part of gabbro. Some portion to the west is, however, composed of a rock which can with difficulty be assigned to either gabbro or gneiss; and the nature of this it would be no easy task to determine, were it not that it is seen to hold a geographical position intermediate between the two.

Towards the east the gabbro softens; its diallage becoming more flakey and its felspar becoming either smaller in amount, or diminishing in quantity. At a point immediately above Kleber Geo it might be called diallage rock, were such a name held to express one composed of *diallage alone*. Specimens of the mineral of fine colour and high lustre may here be got (D. and H.) the finest being those which have acquired an increased lustre from exposure.

Eastward of this spot, the rock, though never actually passing into serpentine, becomes markedly serpentinous; beds of chloritic slate, steatite, "potstone," and actynolite-slate prevailing.

These are best seen, indeed in the peninsula are almost confined to the bight called Kleber Geo.

In the Edinburgh Philosophical Journal, vol. x, page 96, we read of the point on which the lighthouse of Scalpa or Glass-island stands—"this point still retains its Norwegian appellation Klibberness, *i.e.* soapstone promontory." In Shetland we find the name of Kleber Geo applied to other localities than this; "soapstone" in the islands is well known, being invariably called a kleber or klemmer stone. It is utilised in two ways. The first, as a chronicle. Any unusually flat cleavage face or "back" of the rock is selected, and upon these tablets of stone may now be read names without number—male and female bracketted in suggestive contiguity—a formal and public declaration of vows, held in Shetland to be as binding as the passing of the hands through the Orkney stone of

Odin—dates carrying one surprisingly far back, the past and the present* are there in no stinted numbers, etched on every available spot on the surface of the rock.

The other purpose to which the Shetlanders apply, or used to apply, this stone is as an unguent. When pounded it was used for cuts and wounds, in the same manner as that other "foreign substance" called laid; having been inserted more or less thoroughly between the cut surfaces, they regarded it as quite as effectual. Being "soft, and clean, and greasy," its application was just as rational, neither more or less.

The *steatite* of Kleber Geo occurs in regular beds, with the strike common to the adjacent rocks: the mineral itself is minutely granular and generally of a reddish-yellow colour. It is occasionally studded with minute crystals of *magnetite*.

To the east of the steatite and further down the slope there are thin beds of *actynolite schist*. This rare rock seldom occurs with well pronounced characters, being generally more a mass of interlacing "matted" crystals of actynolite,—more an actynolite-rock than a schist. Here, however, it is markedly schistose, splitting with ease into thin flakes; these are considerably contorted, and as the interlacing fibres which form the rock are very delicate, and the amount of quartz granules is almost imperceptible, it is of necessity very friable and tender. It is of an unusually pale green colour.

To this rock there succeed beds of "*potstone*," which pass into massive *chlorite*.

No two authorities seeming to agree as to the nature of potstone, and their descriptions thereof differing widely,† I am fain to take refuge in the definition of Nicol, "Potstone is an uncertain mixture of talc, chlorite, and other minerals. There is a safe vagueness in this,—it will easily include the rock to which I here apply the name. Its general appearance in these islands, however, goes a long way to induce me to prefer Dana's definition—"ordinary soapstone, more or less impure."

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* And those of many who it is to be suspected never were there. A fervently constitutional conservative gentleman, who was once on the spot with the writer, availed himself of this licence, by engraving the name of the reigning monarch in characters of loyally surpassing depth.

† *e.g.* In Jukes' Geology, p. 83, we read "Potstone includes the impurer, granular, dark-coloured varieties of *steatite*;" p. 143 we read "Potstone is a massive form of *chlorite schist*," In Cotta, p. 251, we read "Potstone consists of a felt-like web of chlorite; sp. gr. 2·8 (?); content of silica, 30—60 p. c. (?)" How long are geologists to be content with such a knowledge of the composition of rocks as is expressed by "30—60 p. c. (?)"? The only full and correct description of potstone which I can find is in Haidinger's translation of Mobs' mineralogy.

This fittingly describes the rock from most of the localities in Shetland, but at the two limestone localities of Lude and Froster Hill, on the mainland of Scotland, its appearance rather inclines to that of ordinary massive chlorite; while in the island of Scalpa, specimens intermediate in appearance are to be found.

Although I prepared for analysis specimens from several of its localities, these invariably were found to contain an amount of visible and non-separable impurity such as forbade their being regarded as a simple mineral—or even a substance of invariable composition;—this relegates them to the category of "rocks."

By a process of mechanical analysis, which I shall describe elsewhere, I have succeeded in separating the several components of potstone, to such an extent as to make them recognizable; and there is this test which I believe will serve to separate steatitic potstone from fine-grained massive chlorite, or the more chloritic variety,—the impression of the nail, or bruise of the hammer on the former is *white*—on the latter *green*.

Premising then that the rock or stratified material to which I shall apply the name oscillates *in appearance* between that of a dark-green massive steatite of a somewhat loose and large-grained structure, and that of a massive granular chlorite of an unusually fine-grained structure (a variety which appears to be special to it when limestone is its matrix), I shall describe the modifications occurring at the several localities in which it is found.

The first of these, which I omitted noting when writing of the mineralogy of Balta, is the Doos, Geo in that island. Here the "potstone" is the basis or "basement mineral" from which the fibres of the altered asbestus have sprung—or upon which they lie.

This is perhaps the purest potstone I know. It forms a thin bed; is of a greyish green colour, has a loose granular structure,—the granules being translucent,—is softer than the nail, gives a white streak, breaks with equal facility in all directions, has an uneven fracture, and is very uniform in appearance. When closely examined with a lens the visible impurities are seen to be minute flakes of talc, specks of pyrite, and granules of magnetite; all apparently occurring in very small amount.

The breaking out of the hard magnetite from the soft matrix invariably destroys sections prepared for the microscope.

By mechanical analysis it was found to contain about a two hundredth part of chromiferous magnetite—a twentieth of flakes of talc—which lay in *one* direction, the bulk being steatite.

The talc was in one sense a thing apart from the steatite,—the powder of the latter was almost white—that of the included talc pale-green. The specific gravity of this rock is 2·806.

The potstone of Kleber Geo differs materially from this; it has a dark-brownish green colour, a close "impalpable paste," which bears an equal resemblance to precious serpentine and to steatite, is studded here and there with minute spangles of lighter-coloured talc lying in *all* directions, and it also contains specks of pyrite, of a black substance in hardly visible crystals, and thin seams of precious serpentine (?) Its specific gravity is 2·787. It is softer than the nail, and is markedly more frangible in one direction, generally showing a subconchoidal fracture.

In this potstone we obtained a single specimen of a lustrous black metallic mineral in thin scales, probably *ilmenite* (D. and H.) If so it is the only instance in the experience of the writer of its occurrence along with steatite.*

The massive chlorite which succeeds to the potstone contains rarely inferior specimens of *magnetite* and *pyrite*. *Asbestus* and *amianthus* (Hb.) also occur. Hibbert adds "much *indurated talc*."

This name is applied with still greater laxity even than "potstone." Mohs and Jameson apply it to talc slate; Hibbert certainly does not regard it as such, as he on the same page describes his talc-schist as something quite apart. Macculloch defines potstone as "indurated talc schist," and gives it as his opinion that "indurated talc" "is of the nature of agalmatolite."

The name implies that the substance *has been altered*; I have observed a substance which appears like steatite of unusual hardness at the following localities,—the granitic belts of hornblendic gneiss in Sutherland; the great granite vein of Ben Capval Harris; in gneiss on Garlat Hill, Tarfside; near Stirling Hill, Aberdeen, in epidotic granite; and in the veins of grey granite occasionally†—this substance proved on analysis to be agalmatolite:—at Ben Capval and Stirling Hill it contained small imbedded flakes of talc. So Macculloch's conjecture as to its true nature was correct.

But that substance I have never seen in association with steatitic or chloritic rocks; and what the substance may be which Hibbert enumerates under the above name, as being associated with *talcose slate* and *steatite*, I know not.

As regards *talc-slate* itself, I have already, in speaking of the application of the name to rocks in Fetlar, shown that I believe there has been in

* I have almost invariably acted upon the principle of sacrificing even a unique specimen of an unknown mineral for analysis, should there be a sufficiency for that purpose,—there was not so here.

† A substance almost indistinguishable in appearance occurs in veins cutting a gabbro on the east side of Beauty Hill, this proved to be *pseudophite*: this was evidently formed by a change in the labradorite.

the older geological writings much of laxity in the application of the term. Indeed I question if there is at present much advance in this respect, or can be in this case and a great many others, until we have analyses and precise descriptions of typical examples.

As an illustration of the amount and character of the information we obtain from "text books" on this subject, I shall quote from two. First from a work of many excellencies, of over 500 pages,—we read:—

"*Talc slate and chlorite slate.* If the mica in mica slate were mixed with or replaced by talc or chlorite we should have (*sic.*) these rocks."

Cotta says of Talc slate,—

"Contains silica 50—57 p.c.

"The principal mass of these rocks consists of talc. It contains little quartz. As it contains less silica than the mineral talc (which has 64 per cent.) we may infer that some chlorite enters into its composition."

Truly it would be a difficult problem to mix a large quantity of a mineral containing 64 p.c. of silica, with even a little of another containing 100 p.c., so as to make a compound which had only 50 to 57! And it would be equally difficult to bring down the percentage of silica by such an admixture of chlorite as would effect the numerical change without simultaneously converting the recognized grey colour of "talc slates" into a well-marked green.

An admixture of margarodite, (with its 46 to 48 per cent. of silica,) with quartz, would, however, yield some such resultant percentage as that required.

There can be no question, however, as to the rocks to which Hibbert applied the name, inasmuch as many of their localities, and the transitions of the rocks into ordinary mica-slate are repeatedly pointed out. I have already shown that certain of the Fetlar rocks to which he applied the name are not entitled to it, and I believe there is great room for doubt in most of the Shetland rocks,—or indeed if the rock which is generally designated by the title in Scotland is so entitled.

Jameson directs us to several localities where "talc-slate" occurs. Nicol states that it is "abundant throughout the Scottish Highlands:"—Some years ago I found my notes and my mind so pervaded with doubts as to there being *any* talc in the slates so indicated and designated, that I separated the glistening, somewhat greasy mineral from several of these slates, and found on analysis that it was *margarodite*, in every case where it was light in colour.

In the case of a brown greasy slate, got a mile east of Cowhythe Head in Banffshire, it was *Biotite*.

Of a yellow one carrying andalusite, from Clova, Aberdeenshire, it was *pihlite*.

What would be generally considered an undoubted bed of this rock, was found by Dr. Gordon, of Birnie, on the north shore of Colafirth Voe;—another, apparently equally entitled to the name, was found by Dr. Aitken and myself in limestone above Milltown Glen Urquhart,—but here it was in so small amount as to function rather as an imbedded mineral than as a rock;—of both of these I shall give analyses, which show them to be margarodite-schists.

The only other rock I know in mass, which has any title, and that a doubtful one, to the name, is one which is composed of crystals of talc lying in all directions, with apparently a small amount of paste of the same. This occurs at the Black Dog Rock, near Aberdeen, as a line of boulders protruding through the sand, doubtless representing an outcrop. The same singular rock I have seen in a dyke a mile north of Keig Bridge, Donside,—but this should be termed talc-rock.

My attention has lately been particularly drawn to this question by a letter from Professor Dana, in which, from his experience among American rocks, he was led to doubt the applicability of the term as used by me in speaking of the schists of Banffshire.

The term was that which had been adopted by several geological writers, —indeed all who have described this district have agreed in regarding it as the most markedly talcose in Scotland.

It was several of these very slates, which I had already found to contain margarodite; but, in consequence of Professor Dana's letter, I have lately made several careful traverses of the district with the special purpose of being in a position to speak to all of them.

I find that the rock which upon hasty examination has most appearance of containing talc is that which is to be seen immediately to the east of the verdigris-green serpentine of Portsoy, and which also appears in greater quantity in the harbour of Whitemills. At Portsoy the rock is about 12 feet in thickness; being at about the level of high water, it has been acted upon in such a manner as to have a great part of its substance removed from its outer surface, a kind of glistening felt of crystals remaining. When broken into it is found to be composed in greater part of clay slate, but this is impregnated to a considerable extent with granular pyrites, and to a much smaller extent with glistening scales,—a mixture apparently of graphite and margarodite,—but some small amount of talc may be present. It stains the fingers of a dark slate blue—is very similar to the Fetlar graphitic schist—and by many would be called an altered alum-shale.

At a single point a rock was found by Mr. Peyton, which consisted of a quartzite with fibrous structure, with adherent talc; this, however, was in coherent layers, not uniformly intermixed with arenaceous quartz.

Altogether I am left in the position of doubting if there is any talc-slate whatever in this "very talcose district of Portsoy."

Minerals.

Though interesting and instructive as regards it rock masses, Kleber Geo is disappointing as a locality for collecting minerals.

Not so, however, another geo which lies on the opposite side of the little bay, directly in the line of strike of the strata. This new locality (D. and H.) contains in small compass three minerals so well marked that all were analysed.

Just under the turf of the steep bank of the inflexure of the coast which is called Pundy Geo, there are to be got specimens of *picrolite* (D. and H. of peculiar appearance. Apparently the mineral has been formed from large pre-existent crystals of actynolite. A layer or bed of some six or eight inches or more in thickness has a regularly columnar structure; the columns, which are easily separable from one another, equal in length the depth of the bed, they are of half-an-inch in width, and have the form of crystals of actynolite. Frequently, however, the structure of these columns is markedly fibrous. The colour is dark-green; the specific gravity is 2·671.

They yielded on analysis,—

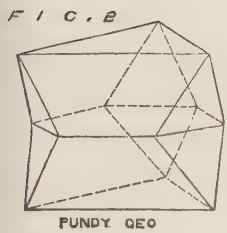
Silica	42·932
Alumina	1·847
Ferric Oxide	5·104
Manganous Oxide	·419
Lime	·8
Magnesia	36·195
Potash	·81
Soda	·366
Water	11·5
	99·973 (H.)

A change of actynolite into serpentine is here shown, and it is almost complete. The columns or pseudo-crystals of this mineral are sometimes kept apart by plates of glistening white *talc* (D. and H.)

Beds of massive *chlorite* (D. and H.) of a minutely foliaceous or confusedly crystalline structure, and a lively green colour are to be seen at the water's edge. Of the fine-grained variety probably the finest specimens in Scotland are to be got here from a tilted bed of six feet in thickness.

It yielded,—

Silica	24·3
Alumina	20·858
Ferric Oxide	3·567
Ferrous Oxide	16·718
Manganous Oxide	·55
Lime	·504
Magnesia	22·2
Water	11·547
	100·244 (H).



Imbedded in this chlorite, magnetite occurs in simple and hemitrope octahedral crystals in great abundance; (D. and H.), and, from the perfection of the crystals and the contrast of their deep colour with that of the matrix, the specimens are of much beauty—being indeed the finest which I have anywhere found in Scotland.

The hemitrope crystals lie with the octahedral face parallel to the bedding of the rock,—the position figured. The crystals are up to about three-fourths of an inch in size, they are of a blue-black colour. Their specific gravity is 5·134.

Being slightly penetrated by chlorite, their analysis showed a small amount of foreign matter.

Ferric Oxide	65·617
Ferrous Oxide	32·166
Manganous Oxide	·5
Magnesia	·684
Alumina	·393
Lime	·223
Silica	·7
	100·184 (H.)

Potstone in small quantity also occurs here.

A small vessel could lie in Fethaland Wick, except during a gale from the east: if forced to run for a harbour that of North Rooe is within five miles. This inlet has a rock right in the middle of the entrance, and somewhat within a line drawn between the two points. The channel lies to the north of the rock—a quarter of the width of the whole mouth of the inlet off from the north point. When well within the bay the craft is to be held somewhat to its southern end. The anchorage is in 3 fathoms at low water. Five miles further south is the spacious and clean bay of Colafirth.

COLAFIRTH.

In the stratified rocks in the neighbourhood of this Voe, and the two immediately to the south, there is an inversion of the dip usual in the gneissose rocks of Shetland. Convulsionists would not hesitate to assign this to the agency of the large mass of granite which lies immediately to the west, and which descends almost to the shore of Colafirth Voe.

It is true that at first sight the strata have much the appearance of a mere fragment entrapped between the granite of Roeness and the igneous rock of the Islands of Yell Sound. What is to be noted here is that the granite, doubtless an eruptive one, has not followed the weakest joints,—the lines of stratification; but both to north and south, cuts across these at various angles, while it runs nearly parallel with them in its centre; but at no spot in which the junction can be seen, is there contact tilting of the beds, fracturing, or indeed disturbance of any kind.

In speaking of the island of Yell, an upper bed of hornblendic gneiss was stated to dip to the north or north west; strata of much the same nature occur with the same strike and dip between Norby and Papa Little at the south-east shore of St. Magnus Bay; so that the strata we are now considering may, with those of Fethaland and Hillswick, be but the highly altered beds of the same upper rock thrown into the ascending fold of an extensive trough.

In the very centre of a trough so formed, and in that portion of it where it is fringed on both sides by granitic flanks, a large mass of what may be meanwhile called a fine grained greenstone appears; and it at once becomes a question whether this is anything more than the product of the aqueo-igneous, fusion of the deeper-seated portions of these hornblendic strata.

Considerable countenance is lent to such a view by the fact that the "igneous rock" consists almost wholly of minute crystals of augite and albite,* while, as will be shown, the typical rocks of the sedimentary series are composed of hornblende and albite.

Traversing from west to east, we here pass over all of the better known varieties of gneissoid rocks; these are admirably displayed along both

* Smaragdite and a, to me unknown—striated red mineral are also visible in the microscope.

the north and south shores of Colafirth, within a stretch of country little exceeding a mile in length.

Starting from the north-western inlet of the bay, we find a peculiar granite, which, from its extreme and prevailing red hue, gives the name of *Roe* to several points of the surrounding district.

This granite is remarkable from the entire absence of mica: it is also peculiar from its extreme massiveness, both on the large and small scale, being singularly devoid of jointing, and in hand specimens appearing more like a solid felspar than a rock which derives its name from its granular structure.

It contains but little quartz; this,—of a massive, white, opaque, and somewhat horny appearance,—is diffused, not in grains, but in a shred-like tortuous manner, as if it had filled up crevices in the other constituent.

The granite has very much the colour assigned to it in the map. Where it approaches the schistose rocks it is much of the nature of a felstone; containing, however, minute granules of quartz and hornblende.

The rock which succeeds to this in passing eastward, I have meanwhile simply called breccia. Still further eastward there is a belt I call aphanite, this again is succeeded by a thin belt of brecciated rock.

Some part of this triple series has been noticed by Hibbert, who also names it aphanite; I quote his description:—

"The aphanite and granite of Northmavine at their junction mutually penetrate each other by extensive processes, showing that they must have consolidated nearly at the same time, and that during this period the consistence of each was in a yielding state. This view is strengthened by the regular and gradual transition which is often shown between the two rocks, each mass receiving or losing hornblende at its junction."

"One of the most curious appearances is presented in the granite to the north of Roeness Hill, by the invasion or inclusion of a dike of aphanite. The line of its course may be easily seen in taking a north-east direction from a point of land on the north-west of Colafirth Voe, between the foot of Colafirth Hill and the commencement of the hills called the Biergs; the disorder that has taken place by the invasion is evinced in the irregular surface of the hill for a distance of five miles. On the west of the granitic mass, the dyke has nearly reached its termination, since it is exposed along the precipices of the coast in the form of smaller veins, branching out in numerous directions, and presenting every variety of form."

There can be no question as to this being the rock I have above referred to, and that it must, a short way north of the point where I observed it, curve round to the north-west; there can also be no doubt—if

Hibbert's description be even in the main correct—that it is, or has *assumed* at the west the structure and mode of functioning of an *intrusive* rock, as he holds it to be; and lastly, there can be little doubt that it will, in the present day of waning Wernerianism, be now generally held to be an *igneous* rock, which Hibbert tries afterwards to prove it not to be.

There are some points, however, in this description, to the accuracy of which I demur.

It must be evident that two rocks, which were in such a yielding state that they were simultaneously mutually penetrating one another, could never form a breccia; and a fragmentary breccia is certainly what does occur next to the granite, at the point noted. There is here no penetration of the granite by the aphanite, as regards processes or branching veins being thrown off from the latter into the former; nor do I believe there is the slightest penetration of the aphanite by *the* granite of the Roe Hill.

The rock which lies between the granite and the aphanite is compounded of sharp-angled fragments, cemented by granitic paste; but that the fragments are derived from the adjacent aphanite, I cannot admit; nor can I admit that the cement is an intrusion from the adjacent granite.

The fragmentary portions—from the size of a hazel nut to that of the fist—some dense in structure, and dark in color, some open in structure and comparatively light in color, are all portions of a laminated rock: they much resemble hornblendic bands in a dark-mica gneiss. The granitic cement, altogether unlike the red granite near it, is a spangled melange of two felspars, white and red, with quartz and mica; it has all the appearance of a product of exfiltration, or of positional rearrangement of the felspathic bands of gneiss;—a something not intruded from without, but extruded from within.

Some of the dark laminated fragments seem opened up by the insinuation of this granitic paste, and to be dissolving away into it.

It seems to be no intermediate between,—no melange of granite and aphanite, but a rock undergoing change. Examined in thin slices in the microscope, the structure of the dark portions is clearly that of schist. The dichroism of the dark imbedded crystals shows them to be hornblende; but there is also a jet black opaque substance, (acting as a paste,?) which I do not know. It has no metallic lustre.

Hibbert remarks—"the relationships of the syenitic greenstone (aphanite) to the granite, though curious, are in the present state of our geological knowledge, of very little importance."

I shall venture to alter this sentence to the following,—the relations of this aphanite with the contiguous breccias, to the granite and to the

adjacent serpentines are of the very highest importance—in our present efforts to ascertain the true nature of metamorphic change. So important that I doubt not that this locality,—the geognosy of which, the greater attractions which mineralogy possessed for me at the time, permit me now to describe all too imperfectly,—will come to be one often quoted in the future.

The true aphanite which succeeds is a very close and minute-grained crystalline mass of a dark-green color. Its specific gravity is 2·925. Under the microscope it appears as an ill-defined aggregate of minute crystals of hornblende, with apparently albite.

The breccia which succeeds this to the eastward, contains large sharp-angled fragments of the same aphanite: these are quite uniform in structure, and quite unlike the laminated fragments contained in the rock to the west. The paste here also is entirely different, being a pale colored porphyritic granite.

This breccia is associated with a thin band of what, in the absence of specimens for microscopic examination, I call black chert.

Eastward of this there is a stratum of considerable width of serpentine;* this, though varying now and again in its appearance, is neither so markedly divided into separate beds nor so characteristic in its colouration as it is in its extension on the south shore of the Voe.

Among the specimens collected by Dr. Gordon, there is a variety which, with the exception of minute diffused crystals of talc, is absolutely structureless, and of a uniform rich oil green colour. This might be improperly called a potstone. Most interesting specimens, showing the evident passage of actynolite into serpentine, also occur.

Others show what is extremely rare in Shetland, mottlings of a dull red, along with white or yellow veins. Dark green is however the general tone, this being sprinkled with minute specks of magnetite, but

* I am indebted to my friend Dr. Gordon, of Birnie, for enabling me to furnish a minute description of the rocks of the north shore lying eastward of the breccia; my time when walking across the section permitting only of my noting the sequence, but not of my gathering specimens of the rocks.

Dr. Gordon, who during several visits to Shetland, had been engaged in independent geological research, kindly went over from Hillswick and took specimens along this north shore, and elsewhere in the district.

Though, from the great amount of *mineral* analysis which I have yet before me, I am at present unable to analyse these rocks, I yet consider several of the specimens collected to be so typical examples of rocks of which we have no analyses confirmatory of the names which have been assigned to them, that I still hope to be able to supply this want. And if so, I take this opportunity of stating that Dr. Gordon purposes to deposit the specimens analysed in the Elgin museum.

beyond it there are not, in the specimens sent to me, any imbedded minerals.

As associates to the above, granular *labradorite* occurs, carrying plates of margarodite, which are disposed within it in gneissose arrangement; and there is also a peculiar margarodite gneiss;—one at least of these rocks can be traced some distance to the south.

Dr. Gorden has observed this serpentine some distance inland in the neighbourhood of the road leading to North Roe; so there is a probability of its connection with the rocks of a similar type which occur at Fethaland.

In close proximity to the serpentine, Dr. Gorden obtained the specimens of the rock which I have above stated would be usually set down as being without doubt true talc slate; it is here of a pale green colour, and high glistening lustre.

The ingredient resembling talc is in excess; it occurs in broad somewhat contored flakes; these the nail readily ploughs up and rolls in powder before it, recognising however an occasional rasping sensation from the imbedded granules of quartz. The substance abraded is perfectly unctuous and may be rubbbed down till the individual foliæ almost disappear.

This, being the most typical "talc-slate" I know, was analysed.

It yielded,

Silica	46·3
Alumina	27·39
Ferric Oxide	5·368
Ferrous Oxide	7·253
Manganous Oxide	·097
Lime	·951
Magnesia	2·26
Potash	4·685
Soda	2·29
Water	2·955
	99·549 (H)

Being compounded apparently of about three parts of margarodite with one of chlorite and one of granular quartz.

The rock is most characteristic in those beds which are in closest proximity to the serpentine.

Analysis has thus disclosed—and on account of the extreme unctuosity and softness of the margarodite analysis alone could have done so—that this most typical "talc-slate" is in reality a margarodite-schist. All these margarodite-schists are fusible before the blow-pipe. Talc-schist would

not be so, seeing that talc itself is infusible. I know no other mode of discrimination.

Eastward of this rock one which may be called a *chloritic* schist succeeds; the word chloritic being employed to designate the *colour*, and not with the intention of insisting upon the actual presence of chlorite.

Many chloritic schists would appear to owe their colour to minutely diffused actynolitic or hornblendic matter; and this may be the case here. The rock upon close examination with the lens shows broad flakes of margarodite, with a doubtful appearance of filaments of actynolite. Though obscured by the margarodite, there is still more of a gneissose than a schistose structure; plicated layers of quartz carry small crystals of felspar, and still smaller ones of garnet. Precision of language would require us to call this a green-mica gneiss.

As we approach the promontary of Scianess, the rocks become normally gneissic

In endeavouring to follow the small portion of these rocks which appear on the west shore of the bay, along the line of their strike, we are from the nature of the ground confined to the beach itself.

The peculiar breccia first described I did not succeed in finding, but in its place there are beds of schistose hornblendic rocks, similar in appearance to the fragments of rock imbedded in the breccia. The aphanite is seen in small amount on the north end of this line; it is followed by, and appears to pass into a rock here ill-defined, but which is afterwards seen to be the continuation of a most characteristic mass, which I have called schistose-diorite.

To the east of this, a massive characterless serpentine occupies two projections. This serpentine is of a dark slate-blue colour, a dense structure, and is profusely sprinkled with grains of *magnetite*. It cleaves more readily in one direction, and hence was probably formed from a laminated rock.

The westerly trend of the southern fork of the Voe again cuts this series, exhibiting a small amount of hornblende rock, lying between the serpentine and the diorite; but, from the low and swampy nature of the ground at this spot, the outgoings of the other rocks are unfortunately not seen at this most important point of their course.

The same cause prevents those members which lie most westerly being immediately taken up in traversing the southern shore of the Voe; here the strata as regards their mere exposure, afford one of the finest sections in Scotland; and, from the nature of the rocks, and the manner of their association, one of the most interesting and suggestive.

I have said that, at the ultimate west point of Colafirth Voe, low ground, or—to put it more correctly,—the absence of shore-cliff escarpment, prevents recognition of the rocks. Inland the covered nature of the ground did not permit me to ascertain whether the aphanite coursed along the granite, to join a large mass of the same rock which lies to the south near Soulan Voe,—and Hibbert seems to have been here equally unsuccessful.

The first rock (after some ill-defined hornblendic strata) which the shore cliffs expose, is that which Hibbert describes as "beautiful." He states that it is composed "of nothing more than striæ of quartz and hornblende;"—in this, however, he was at fault.

The highly characteristic rock strikingly resembles a page prepared for manuscript music,—that is to say, it is crossed at more or less regular distances, by systems of narrow parallel lines with broad intervening spaces, the lines being dark, but the spaces light in colour.

I agree with Hibbert as to the nature of the dark mineral; the lines are formed by numerous interlacing crystals of platey or sub-fibrous hornblende, disposed in laminated arrangement, (uralite ?)

The white mineral which, filling the intermediate narrow and broad spaces, has been taken by Hibbert for quartz, is however *albite*, in confusedly arranged, coarsely striated crystals, which have somewhat of a vitreous lustre.

Two other substances, moreover, go to form the rock,—disposed in a flat position between the hornblende and the albite, there is a spangling of small plates of *margarodite*, and, in association therewith, and there only, there are crystals of *pyrite*. In the specimens obtained, which were necessarily near to the surface of the rock, this pyrite had become *limonite*. Beautiful in itself, this rock is occasionally rendered markedly striking by diagonal shifting,—an apposition of narrow to broad layers frequently resulting.

To this schistose diorite there succeed thin beds of hornblende and serpentine, with, according to Hibbert, "beds of quartz, and a small amount of a pure white limestone." Neither of these I here saw, but, instead, a second but very inferiorly marked bed of the "beautiful rock"; and here Dr. Gordon obtained specimens which exhibited an evident, and it it may be said a *palpable* transition into serpentine. The hornblendic mineral is quite soft and falls to a greasy powder before the knife, which also when drawn over the felspar sinks into it with a smooth sliding motion. The rock-rents, moreover, are coated with a serpentinous crust.

Beds of "potstone" (Hb) occur in the series of strata of serpentine which follow; these are also separated by thin layers of hornblende-rock, and hornblendic gneiss.

The different natures, the order of arrangement, and the bulk of these beds of serpentine calls for notice.

The most westerly bed is a dark green, dense serpentine, carrying minute crystals of talc, but otherwise featureless; this may be Hibbert's potstone. To this succeeds a very pale yellowish-green bed, of a somewhat loose and granular structure, which is pervaded throughout with what may be called dendritic markings; these are of a dark blue colour. They differ from ordinary dendritic marking in this, that they present much the same appearance in two directions of fracture at right angles to one another. The color, structure, and appearance of this rock are altogether so characteristic that it is an easily recognise one.

To this there succeeds a bed of granular green serpentine, which, in some of its layers, is pervaded with *chrysotile* ("*amianthus*," Hibbert) of marked peculiarity of arrangement.

Lastly, there follows a bed which, like the first, is massive and structureless, but which has a peculiar verdigris-green colour.

Most of the interest connected with these beds lies in this, that not only in identity of structure, but also in order of occurrence, and in bulk, they correspond in a very striking manner with the series of beds of serpentine which are to be found, with the same strike and similar dip, at Portsoy in Banffshire.

Here also a dark green serpentine occurs to the westward, followed by a pale bed, the specimens of which are indistinguishable from those at Colafirth; this is succeeded by a chrysotilic bed, while a verdigris green mass terminates the series to the eastward. As for the width, Hibbert states that he found two of the masses at Colafirth to be 90 and 240 feet; the writer found the two principal masses at Portsoy to be 80 and 240 feet.*

Eastward of this series of beds of serpentine the "beautiful rock" again appears, but its features are not here by any means so well

* I should add in connection with this series that among the rocks forwarded to me by Dr. Gordon, there are two which I and my confrere Mr. Dudgeon did not observe: 1st, a *talc rock*, which was interesting and typical. It seemed to consist of plates of pale green talc, with a very little actynolite; these are twisted into one another in a singular manner. The knife also suspects the presence of granules of quartz. 2nd, a crystalline granular variety of the beautiful rock (?) containing specks of pyrite; this is very like an igneous rock in structure. I have seen large rolled masses of this rock near Hillswick.

marked. A vein of mixed crystals of albite and quartz is next seen, shortly succeeded by one of white granular marble of close texture. To the east of this, massive hornblende rock for a short space occurs, succeeded in turn by a rock which, according to Hibbert, "is composed of quartz, and of a white talc, which takes the place of mica." The white talc I believe to be margarodite. "Chloritic" and micaceous schists, similar to those of the north shore, with a very micaceous gneiss, terminate the section.

In crossing the section, as seen half a mile south, along the north shore of Quyfirth, we find a very inferior exposure, ill-defined types, and apparently intermediate varieties:—the dioritic beds seem to have thinned out, and the serpentine does not present distinctive features; it is indeed seen to be evanescent a short distance up the opposite slope.

The interest of the section is now much diminished; the gneiss is still hornblendic to the west, chloritic rocks are seen in the neighbourhood of Ollaberry, while, at the extremity of the Ness, granitic porphyry in small amount impinges upon gneiss.

Having been specially engaged in working out the mineralogy of the locality, time did not suffice for my attempting to solve the problem or problems which the sequence and position of the rocks here evidently presented.

To anyone attempting to solve these problems, in will be apparent that he must, as a necessary preliminary, enter upon the consideration of the nature of all metamorphic change, and the origin of the so-called metamorphic schists.

That question at present very much resolves itself into the general one, whether these rocks are products of change *in* pre-existent rocks, —products of a change in rocks which had been sediments *resulting from the degradation* of pre-existent rocks,—or of a change in rocks which had been *sediments from solution* in superincumbent waters.

According to the first hypothesis, there is from first to last no change in locale; according to the others there is a necessary, probably a very considerable change in locale.

A special consideration of the very various modifications of the crystalline schists, which the Scottish Highlands afford, leads me to give my adherence to the second of these views, almost without reserve: the views which natural occurrences and natural phenomena as there seen, induce me to adopt, being similar in the main to those entertained by Dr. Sterry Hunt, as expressed in the preface to the new

edition of his "chemical and geological essays," I here present that author's views contrasted with my own.

DR. STERRY HUNT.	THE AUTHOR.
"The crystalline stratified rocks are not Plutonic, but Neptunian in origin, and, except so far as they are mechanical sediments coming from the chemical and mechanical disintegration of more ancient rock masses, were originally deposited as, for the most part, chemically formed sediments or precipitates, in which the subsequent changes have been simply molecular, or at most confined to reactions in certain cases, between the mingled elements of the sediments."	The crystalline stratified rocks are not Plutonic but Neptunian in origin, the lower members being usually mechanical sediments—coming from the mechanical and chemical disintegration of more ancient rock masses,—were originally deposited by the simple process of sedimentation; the upper may have been thrown down from suspension by some process of chemical precipitation. The characteristic features of both have been conferred upon them by the agency of the crystallipolar and chemical forces operating in the presence of the joint influences of heat, pressure, and moisture.

There is a certain class of clayslates which I would exclude from the above, namely that which, occuring abundantly in Scotland in Banffshire, and the intersecting portions of Aberdeenshire, contain throughout—irregularly disposed,—such minerals as kyanite, staurolite, andalusite, and, above all, chiastolite.

Without doubting that metamorphism has ultimately altered such rocks as a whole, I do not conceive that it is at all necessary to call in the aid of any obscure combination of forces to account for the presence of those minerals throughout their mass.

Such minerals might readily result from chemical changes taking place in that mass while it was still plastic; or between the constituents of that mass and the superincumbent waters of a richly-mineral ocean.

The crystallipolar force alone would determine their separation as isolated crystals, before the solidification of the pulpy mass into solid rock.

And while admitting that metamorphism might render a water-soaked rock sufficiently plastic for mineral molecules (resulting from exalted chemical agencies) to segregate each to its fellow, it is somewhat difficult to understand how a complex structure like chiastolite could be formed in a mass in which there was not the most perfect mobility.

As regards this particular case, I find myself in disaccord with Dr. Sterry Hunt, who enumerates it as one of the minerals which may be formed in the mass of pre-existant rocks under the influence of high temperature and saturation with thermal waters. At page 306 of his

essays he writes, "In the mechanical sediments of later periods, certain crystalline minerals may be developed by a process of molecular rearrangement,—diagenesis. These are, in the felspathic and aluminous sediments, orthoclase, muscovite, garnet, staurolite, cyanite, and chiastolite."

While it is far from difficult to suppose the chemical and crystalline forces drawing together—even out of a semi-solid mass—the ingredients which, by some such interchange as indicated by Dr. Hunt below, would form the first five of these minerals, it is difficult to imagine these forces arranging, in such a mass, a structure so singular in its relationship to the mass itself as chiastolite.

Would the mighty force, whose operations drew together the white portions of these crystals, suddenly and whimsically suspend its operation; leaving a certain amount of what is usually regarded as the material of the rock mass itself, to prevent complete union?

Are we to assign to the crystallipolar force the ability to confer upon a certain portion of the black mass (which was elsewhere unable to resist its demands,) a power which actually prevented the completion of its effort to draw the white material to a common centre?

While it may be said that the same argument to a certain extent will apply even to a *fluent* menstruum, and that any argument which explains the want of central contact by an assumed repellant polarity in the four light-tinted portions of the fabric, applies thereto also, still it can only do so to a much smaller extent; and it must be admitted that a greater amount of probability must lie with the formation of complex crystallizations in situations where there is the most complete mobility of particles.

Notwithstanding which finding, it is not difficult to show that chiastolite crystals still more thoroughly definitively negative, it may said, the view maintained by Credner, that the crystalline minerals imbedded in metamorphic rocks, were produced in the ocean in which their pabulum was being deposited, and so simply sank into the mass of these rocks.

If the central four-sided wedge of chiastolite be composed of the rock mass itself,—as it is regarded to be,—how could it, an *amorphous* body, have, in a great mass of water, been concreted in virtue of the *crystalline force*, during the operations of that force upon the white truly crystalline portions of the mineral?

Crystals of chiastolite *must* have been formed in the midst of the mass which holds them,—but that mass must have had its particles in a state of loose coherence.

And so for most crystals of andalusite also; for these, in such rocks, very generally contain uniformly throughout more or less of the micaceous and siliceous matrix, caught up in the act of their assuming a regular form.

Another fact connected with andalusite and chiastolite crystals also tells against Credner's view, namely, that these crystals are imbedded in the rock *in all conceivable positions;* and in some chiastolite slates, as that of Portsoy, in no one position in greater amount than any other.

Supposing such crystals to have been formed in superincumbent waters, it is conceivable that a certain number, on settling, penetrated the sedimented mud with their terminations, and remained poised till they were silted over; but that number must have been small in proportion to that of those which either tilted from such a poise, or which originally fell to the bottom in the more probable position of alighting on their sides.

While the locality described above is one in which many of the questions connected with metamorphism can be advantageously studied, there are two questions connected therewith which more immediately force themselves upon consideration.

The first,—is the serpentine here, a product of the metamorphism of a readily transmutable variety of the rock with which it is geographically connected?—The second, has the schistose diorite actually been transmuted into the aphanite of the northern side of the bay;—does a rock which is unmistakably schistose when it occurs among schistose strata, function as an igneous rock when within the grasp of the granite? For although there are no traces of such appearances on the shores of Colafirth, Hibbert asserts, and bears out his assertion by sketches which show that "it is exposed among the precipices of the west coast, in the form of much smaller veins branching out in numerous directions."

While as regards the first of these questions, I, as the logical consequence of a train of argument submitted in the pages of the Transactions of the Royal Society of Edinburgh, stand committed to hold the affirmative view, I have to admit that I was myself unable to adduce any *direct* evidence from the rocks of this locality.

As regards the second, again, I was strongly inclined to think that the northerly disappearance of the "beautiful rock," in presence of the continuation of the serpentinous belt, might not constrainedly be explained by supposing it to be converted by an igneous mass which had enveloped it, into the aphanite which is its geographical continuation, and which must be nearly identical with it in composition.

The value of *more light* is well shown by this, that three specimens selected by Dr. Gordon merely as types of the rocks, almost prove the correctness of the view held, as regards the first of these questions, and go a long way to disprove the second.

The first of these specimens were that of the actynolite rock of the north, and that of the "beautiful rock" of the south side of the Voe, both of which were *softening into serpentine;* the other was the apparently igneous rock mentioned in the foot note of page 187, and which was stated to be identical with loose masses at Hillswick.

It has to be admitted, as regards this last specimen, that I do not know of the occurrence of this particular type of rock as occurring in the igneous mass to the east of Urie Firth, but it must occur at no great distance from the only spot where I observed the loose masses; and if it forms a portion of that great igneous mass, and sends a prolongation or dyke up among the weaknesses of the junctions of the stratified rocks, and is continued merely with darkened and finer grained features, plugging some rent in the granite, we have some definite record of the relative age of these rocks.

It has been before noticed that the large mass of igneous rock east of Urie Firth may be a continuation of the great dyke which cuts off the schists of the Fitfiel Head: if this injection cuts at the same time the sedimentary rocks at Colafirth and the granite of Rona's Hill, this "epidotic syenite" of Hibbert must be the more recent rock.

Minerals.

On the north west shore of the Voe, a single ill-defined crystal of *tourmaline* was found imbedded in a Biotitic schist (H.)

At a spot on the west shore, marked on the map, where the serpentine touches hornblendic rock, fair specimens of *actynolite*, and radiating crystals of green *hornblende* occur (H.)

From the numerous junctions which occur on the south shore of Colafirth it might be expected that the locality would be rich in minerals.

The coast, from the first appearance of cliffs, to as far east as the pier, is the site where they occur.

The *Albite*, which formed the white layers of the schistose diorite, mistaken for quartz by Hibbert, yielded on analysis:

Silica	66·8
Alumina	17·832
Ferrous Oxide	1·128
Lime	1·504
Magnesia	·138
Potash	·919
Soda	11·517
Water	·484
	100·322 (H.)

In structure this albite somewhat resembled a granular marble, consisting of a mass of crystals lying in a every direction. Its specific gravity is 2·622.

The hornblendic strata which follow yield perhaps the most beautiful specimens of *hornblende* (Hb.) which I have seen.

These specimens consist of bundles, bunches, or plumes of coarse bristling fibres of nearly a foot in length, of a jet black colour, and a brilliant lustre. When most fibrous, plates of bronzy *Biotite* (or *Haughtonite* (D. & H.) are sparingly distributed throughout their mass.

Here also are to be found large speciments of green *actynolite* (Hb.) of unparalleled magnificence; bunches and bundles of lustrous crystals of a fine green, radiate into white albite; plates of bronzy Biotite diversifying the appearance. Hibbert adds *kyanite*, this we did not find, it doubtless occurs in the quartzose belts.

The *Chrysotilic* serpentine contains that mineral in a form which admirably illustrates one of the varieties of vein structure. (D. & H.)

As is invariably I believe the case with this mineral, its fibres run transversely to the course of the minute veins which carry it. These veins occur with an anastomosing structure, somewhat like the fibres of an untwisted cord, spread out in a flat arrangement to a width of a couple of inches. The silky fibres are of a yellowish grey colour; on account of their delicacy, their fine lustre, and the peculiarity of their structure, they form specimens of high beauty.

At this locality, *mountain-felt* occurs sparingly (D. & H.); and delicate crystals of *arragonite* lodge in the rents of the pale serpentine (D. & H.)

The vein of *Albite* (D. & H.) consists of a protruding belt of that substance four or five feet in thickness: large, lustrous, foliated, snow-white crystals* of the mineral are separated from one another

* Under the microscope albite has an appearance, by polarised light, which is quite distinctive; the optical characters of this and other felspars will be considered apart.

by hyaline massive quartz, which is sometimes graphically arranged; the exclusion of the quartz for analysis was unusually difficult. This albite is markedly the finest I have seen in Scotland. Though there are no free crystals, its cleavage faces are of large size, great purity of appearance, and brilliancy of lustre. It rarely exhibits striation to the lens. Its specific gravity is 2 61. It yielded—

Silica	66·838
Alumina	16·733
Ferrous Oxide	2·42
Lime	·942
Magnesia	·372
Potash	·733
Soda	10·76
Water	·894
	99·692 (H.)

On the hill slope, south of Quyfirth Voe the serpentine was opened up for *chromite*, traces only were found; the serpentine here, however, has much of the appearance of that variety which is the ordinary matrix of chromite, possessing what might be conceived to be the mixed characters of the several beds which here coalesce.

At a point indicated as a mineral locality in the map, intermediate between the serpentine and the hamlet of Ollaberry, a massive granular white felspathic mineral occurs.—(D. & H.) It contained specks of pyrite, and was hardly pure enough for analysis. It would be ordinarily called "*Saussurite*," a name generally adopted for every unknown massive felspar: this doubtless is in the line of the continuation of the labradoric rock found by Dr. Gordon on the north side of Colafirth.

In close proximity with this a singular specimen was found (D. & H.) This consisted of a mass of rough crystals in parallel disposition, implanted upon massive quartz. They were of high lustre, yellow colour, and appeared to consist of talc pseudo after kyanite or actynolite.

Gold was said to have been found in quartzose veins at a place called Back, in the north east corner of the Ness, near Ollaberry.

Having inspected the single specimen said to have been there found, I have to say that it consisted of a rubbed specimen of rich yellow gold, imbedded in a greasy white quartz; that both gold and quartz are identical in appearance with those of Australia; and that veins

carrying this variety of quartz were nowhere seen to occur in the locality named as the site from which the specimen was brought.

Dr. Gordon sent for my inspection three specimens from the Loch of Burroland, the site of an old Broch; this is on the south side of the road from Ollaberry to Hillswick, and east of Punds-water loch.

Two of these specimens were junction rocks, consisting of a mixture of pale grey hyaline *labradorite*, with crystals of *margarodite*, and a general admixture of calcite.

This probably gives us the strike of the labradorite which appears on the north shore of Colafirth.

The third specimen was a massive granular grey limestone.

"Certain archæologists hold that one of the reasons for the Brochs being dry stone biggings, is that there was no limestone to be had,—otherwise the builders would have used mortar." This Broch, however, has been built on or beside the only bit of limestone in the district.

Were archæologists to become more or less of geologists, they might be aided now and again in suiting their theories somewhat better to the facts of the case.

FROM HAMNA VOE TO TANGWICK.

The whole south-west of Northmavine, from Roeness Voe to the Bay of St. Magnus, is composed of igneous rocks of Old Red Sandstone age. Only at two spots—the Falling Stack at Roeness Voe, and the Rock of Door-holm, is the sandstone to be seen. A comparison with the rock of Papa Stour, and that of the Mainland near Melby shows their identity.

The igneous rocks may, in some localities in this district, be seen to have flowed out in sheets, for the most part they are ashy or amygdaloidal. Beds and dykes of porphyry occasionally are to be seen, and the ordinary "claystone" rock is often porphyritic in structure; containing soft and readily disintegrating crystals of yellow or light-coloured felspar.

The chief interest connected with the geognosy of this district relates to the striking manner in which it has suffered from the inroads of the sea; there being probably no other spot in Britain which affords such evidences of its power.

This has been assigned to the coast being here exposed to the "uncontrolled fury of the western ocean." It certainly may be the case that the height of the cliffs and the depth of water adjacent thereto may be such as to be peculiarly favourable for the direct application of the force of an Atlantic billow, but this coast is no more specially exposed to the uncontrolled fury of the waves than any other stretch of shore which is unprotected by breakwater-skerries or islets.

The unrivalled illustrations of the devastating and disrupting power of the roll of mighty surges, which this shore affords, is altogether due to the nature and the local circumstances of its rocks.

The interest of the district, both in the above respect and in its mineralogy, lies between Hamna Voe and the Door-holm.

The rocks which encircle the coast, vary from a minimum height of 60, to a maximum of 147 feet; being, from their nature, of loose structure and easy disintegration, they everywhere have suffered much from the assaults of the waves, which have hewn their mural faces, and cut out their deep and burrowing caves.

The first noticeable special illustration of the power of the ocean, however, is a most unexpected one.

From the brink of the cliffs the land falls into a slight hollow or parallel valley, to rise again, somewhat steeply, some quarter of a mile landward, on the swellings of a hill. This valley is swathed in a turf of truly wondrous richness. Hibbert thus describes it :—"I pursued my way along a high gradually ascending ridge that impeads the ocean, which is covered with the finest and softest sward that ever refreshed the tired feet of the traveller, being frequently resorted to by the inhabitants of Northmavine, on a fine Sunday evening, as a sort of promenade. The verdure that embroiders this proud bank, on which numerous sheep continually feed, pleasingly harmonizes, on a calm day, with the glassy surface of the wide Atlantic; nor is the pleasure less perfect when the smooth coating of so luxuriant a turf is contrasted with the naked red crags which form the precipice below, whitened with the spray of the breakers which continually dash against them with angry roaring. The rich surface of pasture which thus gradually shelves from the elevated ridge of the coast, bears the name of the Villians of Ure; and well might we apply to this favoured spot of Thule, the compliment that has been often paid to some rich vale in England, "Fairies joy in its soil." After a distance of three miles this gladdening prospect of fertility is suddenly closed with the harsher features that Hialtland usually wears."

Now, in Shetland, the verdure of this "proud bank" is held to be the offspring of the fleecy foam and saline rain which so frequently deluges it,—of the surge which so often sweeps its slopes.

The harsher features which Hialtland so frequently wears might more fittingly be assigned to such a cause; a sweeping surge is not generally pregnant with such sweet influences; many spots may be seen on the western coast of Orkney, they are doubtless not unfrequent in Hialtland also, where the turf-crowned brows of cliffs, two or three times the altitude of these, are rutted, and riven, and scalped by the back-tow of the sweeping surge.

The true cause of the fertility is not far to seek; loose-lying on the sward, dotting it everywhere as they chance-thrown fell, are fragments, large and small, down to the pulverised shingle of the rich alkali-charged rock. The more massive fragments have, with no little toil, been rolled aside to form dykes; the smaller lie air-rotting, till the sward creeps over them The devastator has here become the enricher; the surge seizes upon the foundation strata of the cliff, first pounds them against its frontlet, then bearing them aloft in its grasp, sweeps them over the crest, and flings them, with loose-fingered sprinkle, far over the land.

The illustrations of the power of the surge, as here seen, are mainly in the transporting of huge blocks, and in the cutting out of deep caverns.

The sky-line of the Holm of Eshaness, which is about 135 feet high, is roughened all along by immense loose blocks, which appear at a distance little less protuberant than the hamlets of the inhabitants.

Of measured movements of such masses, Hibbert mentions the following:—

8 feet	2 inches	x	7 feet	x	5 feet	1 inch,		carried	90 feet.
17½	,,		,, 7	,,	2	,,	8 ,,	carried	30 ,,
9	,, 2 ,,		,, 6½	,,	4	,,		carried	150 ,,
9	,,		,, 9	,,	9	,,		thrown	up.

A group figured by Hibbert, and consisting of blocks about 8 feet cube, has been broken to fragments by being thrown against one another; this demolition took place while they lay some distance from the edge of a cliff 86 feet in height. Jameson mentions a mass 12 tons in weight which was torn out of its bed 90 feet above the ocean, and thrown two fathoms inland.

A mass somewhat less than one cubic yard was seen by Mr. Dudgeon and the writer lying toppling upon the edge of the cliff, where it was 135 feet in height; this *must* have been thrown up, for it consisted of hard porphyry, and a bed of this lay at the very base of the cliff at the water level, the whole of the superincumbent mass and all the rocks around being amygdaloidal.

At the spot called the Grind of the Navir, a mass, thirteen by twelve, by five feet, was thrown laterally a distance of thirty feet, and twenty-five vertically; it has since been several times rolled over; the original bed of this mass was seventy feet above the sea.

It is at this spot that this work of destruction is most apparent, and it is here also that it can be clearly shown that such illustrations of the prodigious power of moving water, occur where the peculiar circumstances of the case have operated in aid of their production.

A small promontory projects westward from the ordinary north and south trend of the coast or cliff line; this promontory, instead of consisting of the ordinary amygdaloidal trap, is formed by a bed of hard porphyry which dips to the south—*i.e.* at right angles to the line of the cliff, at an angle of about 10°; this bed projects sea-ward for about one hundred yards; at its highest point, where there is a level platform, it is about seventy feet above the sea. To the north, it falls over in rough and broken cliffs; landward, the amygdaloid overlaps it

in a bed, which at its highest point is twenty-feet in thickness, at its lowest, where the porphyry dips beneath the water, this amygdaloid bed is about ninety feet in height.

Seaward, this porphyritic platform and terrace is cut off by a dyke of porphyry, which rises some thirty feet above the platform, and so presents a vertical wall to the western ocean of about a hundred feet in height.

Opposite the very centre of the level platform, the sea has forced an entrance through the upstanding dyke, cutting it square down, even below the level of the platform itself; and strewing the latter with the ruins of the breach, which now presents itself as a mighty portal, flanked by stupendous walls.

The ruins of that portal would delight the heart of a quarryman.

Sapping with gentler plash into the jointings of the porphyry, the waters have loosened the cuboidal blocks, so that the winter's billows lifted them out of their beds, and now tosses them into heaps which lie disposed according to the set of the waves. Smooth-surfaced and sharp-angled, no chisel-work would improve them. Masses from six to eight feet in length, and of proportionate width and depth—a wealth of building material—lie pitched in every position, tier over tier.

These heaps of stones are generally disposed as two great mounds, which stretch landward from the shelter of the pillars of the portal; but when the surf rolls up from north or south, they are scattered over the platform, only to be swept back again behind the rampart by the first storm from the west.

The process and the progress of all this ruin is very apparent; southerly and northerly gales swept from off the terraced platform the cap of amygdaloid which once buttressed the great porphyry dyke: doubtless its massiveness enabled it long to resist all direct assaults in front; but a flank attack prevailed. An inner dyke of less enduring material penetrated it from the north; this was sapped out, and now appears as a narrow geo, up which the water dashes. The great dyke, thus reduced to two of less than half the width, had collapsed, and the ruins of the outer portion doubtless aided in the battering down of the inner.

To the weakness incident upon a jointed structure, has also to be assigned the singular recesses which the waves have scooped out, at what are called the Holes of Scraada, and the Cannon.

At these points, dykes of porphyry, which had penetrated the cliffs at right angles to their escarpment, have been sapped out; but here

the waters, being confined in their action, have removed only the lower portions, leaving the upper as the keystones of the arched roof.

At the Holes of Scraada that roof has, in two places some hundred feet inland, fallen in ; the debris has been swept away, the shafted openings greatly enlarged and deepened, so that now two seething chaldrons of foaming waters may in storms be seen, cliff encircled, and apparently unconnected with the outside waves. Into the inner of these chasms the waters of a stream are precipitated in a cataract,—they had doubtless done some amount of the tunnelling.*

Minerals.

The traps of Old Red Sandstone age are as a rule far from generous in their supply of "simple minerals ;"—this is markedly the case here.

The "porphyritic claystone" yields, some fifty yards south of the Cannon, in small flat druses, an olive-green to fawn-yellow "steatitic" looking substance, soft and of a soapy feeling—doubtless *saponite* (D. and H.) Here also *rock-crystals* and *amethyst* occur in pyramidal crystals (D. and H.)—both being traversed by spicular crystals of *limonite* of a rutilic colour,—"fleches d' amour" (D. and H.)

A little bight immediately south of the point which is opposed to the rock of Door-holm, has cliffs of a rotting porphyry, which yields *agates*, and *chalcedony* sheathing fibrous zeolite (? natrolite) D. and H.

Hibbert states that the rock of this district, "in some places," contains cavities lined with chalcedony coated with *calcite* and rock-crystals —also occasionally with "green earth,"—doubtless *saponite*.

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* The vacuity left by the washed out dyke at the Cannon, has two openings—one which is constantly beneath the waters, and is unseen ; another circular, and about a yard in width, is a little above water level. The inner chamber is of such profundity and form, that at certain states of the tide, the included air pent up by an inrolling surge, asserts its elasticity upon the compressing liquid in its back sweep, in such a way as to catch some of its upper waters and discharge them, dissipated into steam This is accomplished with terrific force, and a noise which, to a near observer, resembles the imagined snort of a leviathan ; while when heard from a passing vessel the reverberation seems like the sound of a cannon. The misty spray is discharged from the throat of the recess with astounding force to a distance of forty yards.

XVI.—*On so-called Green Garnets, from the Urals.*

By A. H. Church.

SOME extremely beautiful but rather soft gems of various green hues have been extensively sold during the last year or two. They are found in the gold washings of the river Bobrowska, near Poldnewaja, district of Syssersk, in the Urals, and occur in the form of nodular masses, varying in size from a pea to a chestnut. These closely resemble the jelletite from Monte Rosa. All the specimens which I have examined present a roughly radiate structure, are irregularly fissured and veined, and are coated with a talcose mineral, glistening and nearly white. The exposed uninjured surfaces of the nodules are minutely and unevenly striated. The mineral shows no cleavages, but the broken surfaces have a resinous or semi-adamantine lustre, and show a small conchoidal fracture. The transparency of the mineral is complete, and its refractive and dispersive power very high, so that the cut stones exhibit a remarkable amount of "fire," especially by artificial light. The colour varies much, ranging from a somewhat yellowish emerald-green through pistachio, asparagus and olive-green to a liver-brown. The hardness of the mineral is about 6. It fuses to a black bead before the blowpipe.

The specific gravity of this mineral may be taken as 3·85. This figure was deduced from three determinations, made with every care by means of one of Oertling's most delicate assay balances. The liquid employed was rather dilute alcohol, three cut and nearly flawless specimens of the mineral in question being used for the experiments, of which the details are here given :—

No. and Colour of Specimen.	Weight in Air.	Weight in Alcohol.	Sp. Gr. of Alcohol.	Temp.	Sp. Gr. of Mineral.
i. green-yellow	1·0446	·8148	·8478	16°	3·854
ii. pistachio-green	·5044	·3929	·8506	13°	3·848
iii. emerald-green	·2188	·1704	·8506	13°	3·8494

Analyses of the pistachio-green variety of this mineral gave the following results :—

Analysis I.—Fusion with potassium and sodium carbonates.

·6895 gram gave ·252 gram SiO_2
·412 ,, $CaCO_3$
·226 ,, Fe_2O_3
·007 ,, Al_2O_3
·016 ,, $Mg_2P_2O_7$

Analysis II.—Fusion with above mixture and nitre.

·5005 gram gave ·308 gram $Ca\,CO_3$
·1645 ,, $Fe_2\,O_3$
·005 ,, $Al_2\,O_3$
·0055 ,, $Mg_2\,P_2\,O_7$

Analysis III.—Fusion with potassium and sodium carbonates :—

·5065 gram gave ·193 gram $Si\,O_2$
·1695 ,, $Fe_2\,O_3$ and $Al_2\,O_3$
·303 ,, $Ca\,CO_3$
·0055 ,, $Mg_2\,P_2\,O_7$

The following percentages represent the above results :—

	Analysis I.	Analysis II.	Analysis III.
$Si\,O_2$	36·55		38·10
$Fe_2\,O_3$	32·78	32·86	33·46
$Al_2\,O_3$	1·01	1·00	
Ca O	33·46	34·46	33·50
Mg O	·83	·40	·39

The mean results (omitting the $Si\,O_2$ of analysis III) will stand thus—

Silica	36·55
Ferric Oxide	32·82
Alumina	1·01
Lime	33·96
Magnesia	·54
	104·88

But further experiments showed that part of the iron in the mineral exists in the ferrous state, a conclusion to which the green colour of the substance also points. In order to dispose of the 4·88 parts in excess in the above analysis, we must assume that the ferrous and ferric oxides in the mineral exist in these percentage proportions.

Fe O	19·52 per cent.
$Fe_2\,O_3$	8·42 ,,

The whole analysis will then be represented by these percentages :—

Silica	36·55
Ferrous Oxide	19·52
Ferric Oxide	8·42
Alumina	1·01
Lime	33·96
Magnesia	·54
	100·00

Now the formula (3 Ca O, $Fe_2 O_3$, 3 Si O_2) for lime-iron garnet demands these numbers :—

Silica	35·43
Ferric Oxide	31·50
Lime	33·07

If, as it seems we must conclude, two thirds of the iron in this Ural mineral exist in the ferrous state, its claim to be regarded as a true garnet can hardly be maintained. Its crystalline character is not only imperfect but can scarcely be recognized. Its hardness, about 5, is low for a garnet, though its refractive and dispersive power is high. Though not unlike jelletite in outward aspect, it does not show the distinctive crystalline structure of that variety of garnet.

The formula which most nearly corresponds to the analytical results detailed above, is 9 CaO, 4 FeO, $Fe_2 O_3$, 9 Si O_2. The following comparison of theoretical and experimental percentages shows this—

	Theory.	Experiment.
Silica	36·19	36·55
Ferrous Oxide	19·30	19·52
Ferric Oxide	10·72	8·42
Lime	33·78	33·96

I do not feel entirely satisfied with the formula I have just suggested for this green mineral. It cannot, however, be considered in any sense a true garnet, for even allowing some excess of ferrous oxide to have been introduced into my calculation, there still remains a serious deficiency in the sesquioxide constituent. Attempts to determine directly the ferrous and ferric oxides present have not as yet been successful, although the simple experiment of moistening the finely-ground mineral with dilute sulphuric acid, and adding a little potassium permanganate solution, proves the presence of the reducing ferrous oxide. Further study of the mineral is required, and it is possible that some such study may have been published on the continent, and may have escaped my notice. I have now set out my own results obtained two years ago, imperfect as they are, for the press of other work still precludes me from completing the inquiry.

XVII.—*On the Magnetism of Rocks and Minerals,*—I. *Serpentine.*

By J. B. Hannay, F.R.S.E., F.C.S.

In a former paper* I pointed out that it was likely that some of the rocks and minerals at present classed as magnetic were so only by reason of intermixture of a silicate of iron having the formula of $Fe_3 O_4$ 2 $Si O_2$, or $Fe_3 Si_2 O_8$, and that when purified from the particles of this body by pulverization and magnetic sifting, they might be found to be either much less magnetic or even diamagnetic.

A portion of serpentine from Aberdeen was chosen, and a careful analysis made of it with the following results:—

$Si O_2$	42·91
MgO	40·04
$Fe_2 O_3$	0·77
Fe O	2·90
$Al_2 O_3$	0·65
Mn O	0·18
Ca O	0·62
$H_2 O$	11·89
	99·96

This was the average of three analyses done from a sample of about 1lb. and no alkalies were found. About 100 grammes were then taken and finely pulverized and sifted through magnetised wire gauze, again pulverized and again sifted till the wire gauze took out nothing more. Strong magnets were then used, and everything taken out which adhered to them. After this an electro-magnet capable of lifting 200 lbs. was made to revolve in a dish so as to stir the powder for about an hour, when the substance was again pulverized and warmed to render it perfectly dry and dusty, and again the electro-magnet was made to stir it. This was repeated till everything magnetic seemed to be removed, the powder was slightly moistened with water containing 0·1 per cent. of gelatine, placed in a tube stopped at one end by a plug, and rammed down till it was hard. It was then heated to about 90° C. and thus formed into a rod. This was forced out of the tube and suspended by a fibre of unspun silk, and allowed to take up a position of rest. The electro-magnet was then brought up from beneath, so that the bar hung between its poles. The rod proved to be slightly magnetic. As it was only faintly so, I determined to carry the work further, so the

* On the Magnetic constituents of Rocks and Minerals, Min. Mag., No. 4.

mineral was again subjected to pulverization and magnetic sifting for some hours, and a portion of it formed into a rod and suspended between the poles of the electro-magnet. It now proved to be diamagnetic as it slowly took up a position at right angles to the line joining the poles. Thus it was proved that my surmise was correct, and one supposed magnetic mineral was shown to be diamagnetic. It remained to determine how much of the mineral and of the iron it contained belonged to the magnetic portion, so an analysis of the diamagnetic portion was done.

The following are the results:—

SiO_2	46·25
Mg O	43·46
Fe_2O_3	0·01
Fe O	1·22
Al_2O_3	0·24
Mn O	0·06
Ca O	0·52
H_2O	8·16
	99·92

Two facts are shown by this analysis—1st, That all the ferric iron had gone with the magnetic portion; and 2nd, that pulverizing and warming the mineral had driven off some of its moisture. The temperature was never over 40° C, and the moisture so driven off was not "quarry sap," as the mineral had lain in a dry cabinet for years. The amount of magnetic substance yielded by the serpentine was 1·95 per cent. The sp. gr. of the original mineral was 2·549, of the diamagnetic portion 2·530, and of the magnetic 3·278.

Checked by the formula—

$$\frac{D}{100} = \frac{1}{\frac{x}{\triangle} + \frac{x^1}{\triangle^1}}\ *$$ we have ·02549=·02543,

which shows that the work was accurately done.

An analysis of the magnetic portion gave the following results:—

Fe_3O_4	60·27
Fe O	0·85
Mn O	1·42
SiO_2	33·31
Al_2O_3	4·02
	99·87

* D = Density of original mineral, x percentage of magnetic, $\triangle$ density of magnetic, x^1 „ „ diamagnetic $\triangle^1$ „ diamagnetic.

From these analyses we see that a portion of the iron as a ferrous compound was not magnetic, or that its slight magnetism was overcome by the diamagnetism of the bulk of the mineral. The presence of ferrous and manganous oxides in the residue in conjunction with alumina is curious, and as it occurs in increased quantity in the magnetic portion, it leads to the supposition that manganous oxide and alumina may form a magnetic combination, as MnO, Al_2O_3 analogous to FeO, Fe_2O_3. I hope to be able to extend this investigation soon to other minerals or mineral mixtures.

XVIII.—*Notes on some Silicates of Copper, with remarks on the Chrysocolla Group.*

By W. Semmons, President of the Liverpool Geological Society, and Lecturer on Geology and Mineralogy at the Liverpool School of Science.

THE vast commerce of Liverpool enables those resident in it to observe some very interesting mineralogical facts, though its position among the gently undulating hills of the New Red Sandstone deprives them of the opportunity of collecting indigenous minerals.

Having in the course of the past few years specially studied some of the chrysocolla ores imported there, I have been very much struck with the vast differences to be detected in most of their physical characters. These differences in fact are of such importance, as will be seen in the sequel, that I have thought it advisable to mention them to some of our ablest English mineralogists and at their request I have been tempted to insert a record of them in the pages of the Mineralogical Magazine. From collections made of these minerals in other localities I have been enabled to make some interesting comparisons, but before stating any of the deductions I have made from these, it will perhaps be better to mention briefly some of the chief characteristics of the stones from different localities.

No. 1.—*From Lower California.*

This large stone shows strikingly a series of gradations from the light earthy variety of chrysocolla, with hardness 1, to the vitreous variety, hardness 5. Beautiful dendritic formations of manganese ore are scattered throughout the specimen, and kupferpecherz is also present. Commencing with the vitreous variety we find it of a dark bluish green colour; this passes gradually into a lighter shade, until we reach a variety with the faintest tinge of blue green, almost white. The light coloured variety is quite adherent and fuses in blowpipe flame, while the dark-coloured variety (typical chrysocolla) is quite infusible, and is non-adherent. Thin veins of the vitreous variety permeate the other, and a layer of calcedony covers them both; this, in its turn, is covered by a layer of calcite crystals.

No. 2.—*Same locality.*

Similar to the light earthy variety described above, but so porous that it floats on water. Colour light blue green. Hardness 1 to 1½. Remarkably absorbent of water (as much as 80 p.c.), and when saturated becomes of a much darker colour. Fuses before the blowpipe. Mr. W. N.

Hutchings, F.I.C., whose assistance in these examinations I would here acknowledge as being of the highest possible value, has analysed this variety, with the following result, which I have placed for comparison with an analysis made by the same gentleman of the hard and vitreous variety from another portion of the same stone.

	Variety—Hard and Vitreous.	Variety—Soft and Earthy.
$Si\ O_2$	67·07	46·45
$Cu\ O$	24·95	39·15
$Pb\ O$	·26	·41
$Fe_2\ O_3$	·27	·48
$Al_2\ O_3$	·55	3·65
$Zu\ O$	·09	·10
$Ca\ O$	·81	·80
$Mg\ O$	·37	·82
$H_2\ O$	5·82	7·99

These minerals were heated to 95° Cent., for some hours, and the water determined by heating to redness.

No. 3.—*Same locality.*

Layers of amorphous felspar and calcedony, sometimes containing crystalline quartz. The felspar, apparently when unchanged of a dull greyish brown colour, passes through various shades of blue to a very dark blue, at the same time becoming richer in silica, and much harder. The silica appears to increase still more until the variety is hard enough to scratch glass. In one instance, this hard blue variety graduates into almost pure calcedony of a dull grey colour.

No. 4.—*Same locality.*

A series of layers, each about 2 millimetres, of gypsum, soft brown hepatinerz, black kupferpecherz and atacamite, with calcite.

No. 5.—*Same locality.*

Resembles vari-coloured jasper so much in appearance, that were it not for an unmistakable piece of typical chrysocolla of the usual hardness thereon, it would probably be taken as such. The colours are blue, bluish green, brown, grey of all shades, from black on one side to white on the other. Dendritic manganese ore is disseminated throughout the entire mass. In some cases there is semi-opalescent quartz mixed with the chrysocolla.

No doubt can be entertained that this stone represents various stages of deposits of copper and silica in solution, sometimes the one, at other times the other, in excess. The solution would also at times have more or less iron or manganese present. The analysis of this hard vitreous variety

shows no less than 67 p.c. silica and 5·8 water, so that the surmise by Berthier, of opal silica being present is probably correct, as both physical and chemical examinations confirm it.

No. 6.—*Same locality.*

A stone of great beauty from the brightness of the colours of the chrysocolla. It consists of irregular layers of "jaspery" chrysocolla (hard enough to scratch glass) and a softer variety hardness 2 and 3. The colours of this jasper variety are various shades of blue, from sky to a deep tint, brown and grey. They all have a roughish conchoidal fracture. In certain portions of the stone are found a decomposing mineral which breaks into irregular pieces, and somewhat resembles starch in appearance, This is found to be composed of an intimate mixture of the chloride and silicate of copper, evidently a passage from the former to the latter. It thus reveals the fact that some, and probably much of this Mexican chrysocolla has been formed by the action of waters containing silica, on the chloride of copper, "atacamite." The occurrences of pseudomorphs of chrysocolla after atacamite, hereafter described, confirm this deduction. In one place the silica, after altering the atacamite, has reached a small fissure, and still retaining copper has deposited along the margin a layer of vitreous chrysocolla, this passes gradually into grey calcedony, and then into quartz crystals, which line the cavity in a similar manner to that sometimes seen in the interior of agate stones, when broken open.

A remarkable fact revealed on the examination of some hundreds of tons of these chrysocollas from Lower California, was the absence of any trace of carbonates in them. In some other lots from same locality, minute portions of carbonate were met with, but always the blue variety, "chessylite," (azurite). The carbonate, moreover, appeared to occur in those stones having a soft earthy decomposed character and containing many minerals, rather than with those more defined in their composition. The minerals occurring with these ores are gypsum, calcite, baryte, quartz, calcedony, smithsonite, and pyrolusite.

No. 7.—*From Utah.*

Is composed of both brown and bluish green varieties. The fibrous radiations of malachite pervade the stone, and as some of these are completely converted into chrysocolla, the stone possesses great interest.

No. 8.—*Same locality.*

Principally composed of the brown and hepatinerz varieties. In a cavity about $\frac{1}{2}$ inch wide at the mouth are several small stalactites of semi-crystalline chrysocolla.

No. 9.—*Same locality.*

Composed of a dark brown variety, with hardness of 5 to 6, with some beautiful incrustations of minute crystals of azurite.

No. 10.—*From Chili.*

In this stone are nodules of a brown red variety, encircled by the blue. As the depth of the blue increases as the kernel (other colour) is neared, there seems to be a connection between the two. The red probably existed formerly as cuprite or native copper, and has since been decomposed. This view of the origin of chrysocolla is maintained by Dr. Burghardt. It is interesting to notice that at one portion of the stone minute crystals of dioptase are met with, while in another, quartz crystals, with native copper interspersed between them, are found.

No. 11.—*From Peru.*

As typical of a parcel some 300 tons this is instructive. It consists of a mixture of chrysocolla, malachite and atacamite, the latter two being generally crystallized. As some characteristic crystals of atacamite are partially converted into malachite, and this passes into chrysocolla, it would appear that the above sequence represents the age of these minerals in this locality. I also find crystals with the characteristic form of malachite converted into a silicate of copper.

No. 12.—*From Peru.*

Represents another large importation of quite a different character. It looks as if it had been subjected to decomposing agencies. Numerous cavities occur in which the chrysocolla is almost crystalline. In some instances layers of small quartz crystals are found, and on these very minute crystals of dioptase of a rich emerald green occur.

No. 13.—*Same locality.*

Contains a mixture of granular atacamite with chrysocolla and radiated masses of malachite. On the exterior portion are minute crystals of sulphate of copper of a greenish colour tinged with blue.

No. 14.—*From Cornwall.*

One of the typical specimens from the celebrated Wheal Gorland mine. Contains well defined crystals of olivenite on pseudomorphous layers of quartz. At the base is a mass of green chrysocolla passing into kaolin. It fuses with ease before the blowpipe.

No. 15.—*From Cornwall.*

A piece of ordinary Cornish granite from South Carn Brea mine. It has a small vein of cuprite about 2 millemetres wide through it. The felspar

crystals on either side have been partly converted into chrysocolla, and this alteration is greatest as the cuprite is neared. The small quartz crystals seem to be surrounded with layers of chrysocolla, while the mica has been quite changed into thin hexagonal flakes of a bright green colour, resembling chalcophyllite.

No. 16.—*From Cornwall.*

This stone, from South Caradon mine, shows very clearly how chrysocolla may be formed by the decomposition of other copper ores. One portion consists of almost pure kaolin; but in another part several nodules of chrysocolla surrounded inner kernels of chalcocite. Examining one of these nodules we find the central portion to be quite compact chalcocite, with the ordinary streak and sectility of that mineral. Proceeding outwards, the streak becomes less metallic and nearly earthy, of a white colour. The mineral assumes gradually a reddish-brown colour, as if some small quantity of iron present had been converted into oxide, and then a layer of chrysocolla is reached. This is first of a deep blue colour, and then shades gradually away to pure white kaolin. The depth of its blue colour appeared to coincide inversely with the adherency of the stone, as if with the increased per centage of copper, the kaolin lost its ordinary property of adhering to the tongue.

No. 17.—*From Cornwall.*

This stone, from the same mine as the foregoing, has small portions of chrysocolla attached to what appear hollows occupying the place of what were once crystals of felspar. No trace of the copper ore from which it has been derived can be seen, but a large portion of the stone is composed of a brown variety containing iron, copper, and clay.

DIOPTASE.

No. 18.—*From Peru.*

This beautiful mineral is found in very small crystals of a bluish green and emerald green colour, on small quartz crystals, in what is evidently a mass of decomposing copper ore.

Although until Dr. Burghardt's description was published, I am not aware of any mention being made of them, I find from that most profound mineralogist, Mr. Thomas Davies, F.G.S., of the British Museum, that the National Collection possesses several specimens from this locality, and it is by no means a rare mineral in that part of the world.

COPPER PITCH BLENDE (KUPFERPECHERZ).

No. 19.—*From Lower California.*

Associated with the large masses of chrysocolla from Lower California are nodules and veins of a dark-brown or black mineral having the lustre of pitch.

The nodules vary in size from $\frac{1}{2}''$ to 6″ in largest diameter, and the veins from $\frac{3}{8}''$ to 2″ in width. Like the different varieties of chrysocolla before described, the hardness is extremely variable, some being about 2, others as high as 6. The fusibility seems to vary with the hardness, and the proportion of manganese contained also exerts an influence on the fusibility, as the higher percentage of manganese the more fusible the stone.

Disseminated through the copper pitch-blende are minute portions of atacamite and chrysocolla, while the minerals associated with it are gypsum (fibrous variety), pyrolusite, calcite, barytes, jasper, calcedony, and quartz.

The following analyses by Mr. W. N. Hutchings, F.I.C., reveal the chemical composition of the fusible and infusible varieties:—

	Infusible.	Fusible.
Silica	27·98	11·95
Oxide of Copper	28·59	14·20
Oxide of Lead	·41	..
Oxide of Iron	10·94	9·35
Oxide of Zinc	1·45	·80
Lime	·92	2 41
Water	8·30	11·61
Alumina	·15	..
Oxide of Manganese	17·53	38·53
,, Cobalt	·35	·95
Oxygen	3·60	7·89
Sulphuric Acid	..	·16
Magnesia	..	2 35
	100·31	100·20

No crystals are met with, or in fact any appearance of crystalline structure. This variety I should consider a typical example of copper pitch blende, and its physical characters may be thus summarized:—Colour, brown, black; streak same as colour; lustre, pitch-like; hardness, 2 to 6; fracture imperfectly conchoidal.

Hepatinerz.—The liver-coloured variety is met with to a fair extent in the Mexican ores, and sometimes enclosed in it are nodules of the appearance and colour of serpentine. In the analysis of these hepatinerz stones the proportion of oxide of copper was found to be 22 per cent., or rather less than in the copper-pitch blende, but probably there is a great amount of variation in the percentages of different varieties.

Pseudomorphs of Chrysocolla after Atacamite.

No. 20.—*From Peru*

In the course of my examinations of the foregoing specimens, I was much struck with the paucity of crystal forms met with. On closely examining with a lens what looked like a mass of minute stalactites of

chrysocolla on a body of atacamite, I found they were in reality minute crystals of atacamite covered by a thin layer of chrysocolla. It seemed as it were that the quondam crystals of atacamite were being slowly changed into stalactites of chrysocolla. Further examinations enabled me to find two specimens where the crystalline form of the atacamite is preserved, while its composition has been changed. The crystals were of peculiar shape, thin tabular plates, and when unaltered resembled "Torberite." It was most interesting to trace the gradual change, as some crystals were scarcely altered whilst others were perfectly changed into chrysocolla.

No. 21.—*From Lower California.*

In this case the crystals are of the usual form—long prisms with usual terminations. They have been completely converted into chrysocolla. In one instance a crystal being broken shows a beautiful section. The central portion has two small holes similar to those seen in "blue lead" crystals and a thin light blue powder can be obtained in very small quantities scattered through the crystal. This is found to be largely composed of chloride of copper and silicate, thus confirming the conclusions drawn from other stones previously described. I believe this is the first notice of the replacement of atacamite by chrysocolla, but I think further examinations will show this has frequently been the case. Previous to this, chrysocolla has been described as occurring pseudomorphic after malachite, chalcophyllite, cuprite, libethenite, galena, cerusite, and barytes. Collins' hand-book to the minerals of Cornwall and Devon also mentions "mica." I have, however, very little doubt that an examination of many of the copper minerals in old collections will show that chrysocolla is the replacing mineral where malachite has sometimes been supposed to be.

From examinations of the specimens described in the foregoing pages, we find that the hardness of these chrysocolla minerals is extremely variable, from 2 to 6 on Mohs' scale; the fusibility also differs in like manner. Further we find that every gradation can be traced from ordinary typical chrysocolla to kaolin on the one side, and quartz on the other. We also find it can be derived from several ores of copper, as we have traced it from cuprite, malachite, chalcocite, atacamite and olivenite.

It can evidently be formed in more ways than one. In specimen No. 16, where a gradual change can be seen in the condition of the ore acted on and also in that of the kaolin surrounding, there seems but little doubt of its resulting from the action of these minerals on each other in the presence of water.

In specimen No. 6, atacamite has probably been acted on by water containing silica in solution. This has converted it into chrysocolla, and the

water passing on charged with both silica and copper in solution, has deposited a layer of chrysocolla as described.

In No. 5 the mineral seems to have been deposited from a solution in which both copper and silica were present, sometimes the one sometimes the other in excess. Dioptase crystals would seem to be formed when the correct proportions for this mineral existed in the solution of copper and silica, and the conditions were favourable for crystallization. It appears to me that some of these masses of so-called chrysocolla may after all be amorphous "dioptase." The nodules and layers of copper pitch blende are probably segregations of a manganese compound from the surrounding mass, as are also the dendritic formations of this mineral and pyrolusite.

The wide differences in the component chemical compounds seem to preclude the possibility of fixing any definite formula for the mineral. Prof. Dana (System of Mineralogy, p. 403) gives the results of 15 analyses of chrysocolla, in addition to the analyses of 11 impure varieties on p. 404.

An examination of these fifteen shows the following .—

	Minimum.	Maximum.
Oxide of copper ..	28 per cent.	.. 45 per cent.
Silica	26 ,,	.. 52 ,,
Water	16 ,,	.. 31 ,,

Some of Mr. Hutchings's analyses are even more striking, showing—

	Minimum.	Maximum.
Oxide of Copper ..	25 per cent.	.. 39 per cent.
Silica	47 ,,	.. 67 ,,

The percentage of silica in ordinary chrysocolla is thus found to vary from 26 p.c. to 67 p.c., and that of the oxide of copper from 25 p.c. to 45 p.c., while water exists in about double the proportion in some varieties than in others. To calculate a formula, which without undue extension or allowance will include all the varieties before named, would tax the powers of our most mathematical chemist. The varieties so merge into one another that it is quite impossible to divide them into separate species.

I have therefore been led to the conclusion that the term "chrysocolla" should be taken to represent a group of hydrated silicates of copper, which vary much in chemical composition, physical characters, and blowpipe behaviour. The term "Kupferpecherz" I should restrict to those varieties of a dark-brown or black colour resembling "pitch" in lustre. "Hepatinerz" I would restrict to those of a liver-colour, if indeed it should be retained at all.

By so doing, we get rid of the absurdity of describing as a definite mineral compound, a class of compounds not one of whose properties is

constant throughout the group. However, by retaining the name "chrysocolla" for the group we avoid the necessity of creating a vast number of new names, for each variety which possesses some character different from the other members of the group would otherwise be entitled to a separate title. Mineralogists can well spare a large number of names which are given to "species" on what seem very insufficient grounds, and I trust one of the advantages conferred on the science by the formation of the Mineralogical Society will be a more rational and complete Mineralogical classification than we at present possess.

XIX.—*Pilolite, an unrecognised species.*

By Professor Heddle.

ONE and all of the writers who notice the substance or substances which have received the trivial names of *mountain cork* and *mountain leather*, agree in placing them among the fibrous amphiboles, intermediate between asbestus and rock wood.

In a monograph of the hornblendes, lately published in the Transactions of the Royal Society of Edinburgh, I have indicated that the above view was probably incorrect; and having, since that monograph was issued, obtained and analysed several specimens from other localities, I now propose to show that this is a substance distinct from amphibole, and from any any other known mineral.

I found upon geognostic occurrence, and chemical difference, alike.

From the published descriptions of these substances, I select those by Phillips and Jameson as being the fullest and most precise,—supplementing their descriptions somewhat by those of other writers.

"*Mountain Cork.*—Berg cork, W.; Asbeste tressée, H.; Rock cork, J. Mountain cork has a fibrous texture, the fibres being interlaced so intimately as not to be recognisable, or capable of separation. It is opaque, has a meagre feel, somewhat resembling that of common cork; about the same hardness; is sectile like that substance; rather elastic, and swims on water. It forms veins in serpentine, and is met with in Norway, Saxony, Spain, and at Portsoy and the Lead Hills in Scotland."—*Phillips.*

"The fibres instead of being parallel, are entangled together like felt, leaving, however, numerous cavities, which give the mass a degree of buoyancy which enables it to float on water."—*Jackson*, "Minerals and their Uses."

"The particles present a loose felt-like texture, no longer recognisable or capable of separation."—*Allan.*

"Its colours are yellowish and greyish white, also ash-grey, and pale ochre-yellow. It occurs massive, in plates that vary in thickness, in forms which are composed of delicate and promiscuous fibrous concretions. Internally it is feebly glimmering or dull. The fracture is fine-grained uneven, inclining to slatey in the larger. The fragments are blunt-edged

It is opaque. It is very soft. It becomes shining in the streak. It is sectile, almost like common cork. It is slighly elastic-flexible. It is difficultly frangible. It adheres slightly to the tongue. It emits a grating sound when we handle it. It feels meagre. S. G. 0·679 to 0·991. It occurs in veins in the serpentine of Portsoy, and in the red sandstone of Kincardineshire; in plates in the lead veins, at Lead Hills and Wanlockhead in Lanarkshire; and in small quantities at Kildrummie in Aberdeenshire."—*Jameson.*

Mountain Leather.—"Differs from asbestus in the position of the fibres. In common asbestus they are even and parallel, in mountain leather they are interwoven and interlaced. It occurs in flexible flat pieces, having much the aspect of leather, but when very thin it has been called mountain paper. It is of a whitish or yellowish or yellowish-white colour, and is meagre to the touch. It occurs at Strontian in Argyllshire, and at the Lead Hills in Lanarkshire."—*Phillips.*

"Occurs in flexible flat pieces, which have an interwoven fibrous structure, and much the aspect of leather."—*Allan.*

"The variety in plates has received the following names: *Mountain flesh*, berg flesh, carno montana, chaire de montagne, chaire fossil; *Mountain paper*, papiere fossile, berg papier; *Mountain leather*, berg leder, cerium montanum, cuir de montagne."—*Jameson.*

It thus appears that Jameson recognised that these were all varieties of one substance.

To these full and clear descriptions I have only to add, that when torn, which is accomplished with difficulty, the marked character of the stone is well seen with a glass,—namely, its *felted* structure; the minute interwoven downy fibres are hardly visible even when using the three combined powers of a pocket lens. I have also to add a property noticed by Dr. Thomson, that it greedily absorbs water like a sponge; and it then "puts on very much the appearance of wet leather." The fibres can, when it is thus saturated, be readily separated from one another.

I have said that in mineralogical works it is placed between asbestus and *rock wood.* This last I do not include with mountain cork and leather, as it manifestly is merely a structural variety of asbestus. On the south shore of Swinaness in Unst, dark-green rigid asbestus is seen passing into specimens resembling decaying wood. In a little quarry on the edge of the great wood of the Bin of Huntly on its north side, and about one and a half miles south west of the Rothiemay Station in Aberdeen, specimens of asbestus, simulating in a most remarkable manner recently split wood, are to be got. On the north slopes of the Hill of

Towanreiff, in Aberdeen, specimens harder, and resembling the fossil wood of Antigua are found; but in all these the nature of the mineral is so evident that I did not conceive it necessary to supply analytical proof.

Such being a full description of the substance itself, its geognostic relations, as contrasted with those of asbestus, have next to be noticed.

Two of the authorities above quoted,—Phillips and Jameson,—say that it is found in veins in serpentine at one locality—namely Portsoy; and serpentine, though generally associated with the augitic type of mineral, does frequently carry asbestus, and does so at Portsoy. I have failed, however, in finding the original author of the statement that mountain cork occurs at Portsoy *in serpentine*. Neither Cunningham, Macculloch, or Jameson, who all worked at this locality, say that they themselves found it in that rock.

In the collection of the late Colonel Imrie, there are specimens marked "Portsoy." This collection was purchased from a local dealer, Mr. Abraham Clark, and to him I believe the assertion is alone due. But this dealer was in he habit of attaching "Portsoy" to almost every specimen in the collections which he sold. The writer had one of these collections with specimens of the giant crystalled diorite of Glen Bucket, ticketted "Portsoy"; Glen Bucket is forty miles to the south of Portsoy. Inasmuch as the Boyne Burn, an undoubted locality of mountain leather, is but a couple of miles from Portsoy, there is great probability that the specimens above referred to were there obtained. The writer, who for three summers was located at Portsoy, searched and better searched in vain for the mineral in serpentine.

Another circumstance which tends to throw doubt on the occurrence of this substance in serpentine is this,—minerals taken from serpentinous rocks, from the nature of these rocks themselves, generally show upon their edges either a passage into the serpentine, or some fragment of that tough and tenaceous matrix adhering to them. Nothing of the kind is to be seen in the specimens ticketted "Portsoy" by Abraham Clark;—they are white or yellowish-white on their edges and surfaces throughout; there is nowhere the slightest tinge of green.

Passing to the consideration of the containing rock in those localities in which the mineral may now be or has been indubitably found, we have it occurring in crevices of granular limestone at the mouth of the Burn of the Boyne in Banffshire; in veins in a decomposing granite at the Burn of Daugh in Upper Cabrach, Aberdeenshire; in the middle of a calcareous vein which cuts the Conglomerate of the Old Red Sandstone at Tod Head, Kincardineshire; in calcareous veins in amygdaloid, near Tay Port in Fife; with some calcite in veins in silurian slate at Waulockhead; and

in sheets in the calcareous gangue of the galena at Strontian,—the vein lying between gneiss and granite.

In no one of these localities does asbestus or a hornblendic mineral occur; in no such association does any filamentous form of a hornblendic mineral occur in Scotland,—if we except the occurrence of tremolite in marble at Glen Tilt, and Shinness, and of augitic-amianthus in marble at Totaig in Invernesshire.

Of information as to the composition of mountain cork, we have the following analyses:

Silica	56·2 ..	62· ..	57·2 ..	51·75
Alumina	2· ..	2·8 ..	..	1·95
Ferrous oxide	3· ..	3·2 ..	4·37 ..	18·90
Manganous oxide ..	..	..	..	1·85
Lime	12·7 ..	10· ..	13·39 ..	14·05
Magnesia	26·1 ..	22· ..	22·85 ..	10·85
Water	..	..	2·43 ..	1·2
	100·	100·	100·24	100·55

The first two of the above analyses are given by Jameson, as by Bergmann; the second is by Scheerer, from the Zillerthal; the last is given by Thomson.

As this last is not stated to have been analysed by himself, has no locality attached to it, had a specific gravity of 2·442, and differs so markedly in the amount of iron and magnesia, it may at once be set aside as pertaining to an altogether different substance.

The others seem to be one and the same substance, but if so it is a substance of a nature totally different from the Scotch mineral.

The first analysis we have which relates in any way to the Scotch specimens is one by Dr. Thomson, which he published in his "Mineralogy," but as this, from the large quantity of water which he obtained, was excluded from all subsequent works on the science, and as my analyses fully bear him out in that respect, I have much satisfaction in inserting both analysis and description in full.

"*Mountain Leather.*

"This term has probably been applied to different mineral species. I confine it here to a mineral which occurs at Strontian, and which I subjected to analysis.

"Colour, light buff.

"Composed of fine threads felted like a hat.

"Feels soft, quite flexible, but tough, and like leather in appearance. Imbibes water like a sponge, and then puts on the appearance of wet leather.

"Opaque; specific gravity 1·334.

"Before the blowpipe curls up, and then fuses easily into an opaque bead. Melts with carbonate of soda into a transparent yellow bead. With borax fuses into a colourless transparent glass.

"Its constituents are,

Silica	51·65
Alumina	9·505
Ferrous oxide	5·805
Lime	10·005
Magnesia	2·065
Water	21·7
	100·73

"Whether the whole water is chemically combined or not is a question. But as the mineral feels quite dry, and may be exposed to the air without losing weight, the probability is that the greatest portion at least, is in combination with the mineral."

The phraseology here is peculiar; it will be seen further on that Dr. Thomson has in the above approached, but no more, to the observation of one of the singular points connected with this, as it is with some few other minerals,—namely, the character or nature of the connection between the water and the other constituents of the mineral—its mode of functioning in the mineral.

Undoubtedly his intention was to have written the last clause, or to have expressed it "is in combination *in* the mineral." But the suggestion as put, is in reality the correct one, though not intended, or perhaps in the least degree seen.

May there not be some part of this large quantity of water in combination with the silica of the mineral, as basic water; and may not some be in a looser state of combination with the constituents as a whole—as free water,—*aqua*,—and hence more readily separable through the operation of those agencies which physically affect water?

Some such mode of functioning as this is what the analyses of others of the minerals obtained in the north seem to indicate.

The analyses I have made are the following:

1. "From Portsoy," according to Abraham Clark's tickets, but in no collection of Clark's that I have seen are they stated to be *from serpentine*.

These specimens have formed part of a vein of about half-an-inch in thickness; they are of an appearance intermediate between that of cork and leather,—only they are nearly white; being old specimens, they are somewhat worn.

Any interstitial matter is a brownish calcite or ochry clay. Their specific gravity is about ·68, and they absorb water only slowly.

The specimens from all the localities were thoroughly air-dried before they were examined.

·77 grammes of this yielded,

Silica	51·428
Alumina	7·515
Ferric oxide	2·06
Ferrous oxide	2·486
Manganous oxide	1·298
Lime	·581
Magnesia	9·35
Water	25·043
	99·761

Of the above water 10·88 per cent. *is lost at a temperature of* 100° *C.*

2. From the limestone quarries at the mouth of the Burn of the Boyne, about two miles east of Portsoy. The mineral is only occasionally met with here; but it must then occur in considerable quantity, as a quarryman described it to the writer as being "like the rotten roots of trees."

It occurs in crevices of the limestone, which is here a high-tilted, much troubled bed, imperfectly stratified, and not highly crystalline.

The only other minerals are crystallised *calcite*, *pyrite*, and an ill-defined shining green substance, probably a mixture of saponite with steatite.

Here the mineral occurs apparently in both its forms of *cork* and *leather*. It can hardly be said that they pass into one another.

The cork adheres firmly to the limesone; the leather is prolonged from it into crevices, which are lined with a grey clay.

The leather is moderately flexible, but not very tough. Its external structure resembles the bundles of muscular fibres which, crossing each other in all direction, form the coats of a stomach or of a bladder. Its colour is pale yellowish grey.

25 grains yielded,

Silica	51·1
Alumina	6·81
Ferric oxide	2·268
Ferrous oxide	2·816
Manganous oxide	1·006
Lime	·86
Magnesia	10·163
Water	23·905
	98·928

Loss at 100° C. 9·2 per cent. of the water.

3. The "cork" which is associated with the leather at the Boyne is of quite a granular as well as fibrous character; it is also slightly yellow, and what is singular, it during the powdering falls down into a rich ochre powder.

It yielded,

Silica	39·88
Alumina	9·444
Ferric oxide	12·544
Ferrous oxide	4·975
Manganous oxide	·1
Lime	1·848
Magnesia	6·879
Alkalies	traces
Water	24·099
	99·769

Loses 7·453 per cent. of the water in the Bath. Notwithstanding the agreement in the amount of water, and in the loss in the bath, this is either a different substance, or is mixed with about 13 p.c. of iron-ochre.

4. The mineral found at the Burn of the Daugh in the Upper Cabrach, is perhaps the finest we know. Possibly this is the true locality alluded to by Jameson, when he speaks of Kildrummie, at least I was never able either to find it, or to hear of its having been found in that parish.

The Burn of Craig, north of Towanreiff, has been given as a locality, and notwithstanding my having myself failed to find it there, I regard it as a likely locality; and I have seen fine large slabs with tickets bearing that they had been there obtained.

I am indebted to a lady mineralogist, Mrs. More, of Portsoy, and to the Rev. A. Gordon, for the specimens which I analysed from the Burn of the Daugh.

The Rev. Mr. Gordon sent me fine pieces, over a foot in length, and nearly an inch in thickness. He informs me that it occurs hardly a quarter of a mile up the Burn, in veins of decomposing granite, and portions thereof are bedded in the specimens.

More than one of these shows a distinct slickenside marking on *one side* of the specimen: the other had manifestly been adherent to the granite during the motion which effected the furrowing.

These specimens show the property mentioned by Dr. Thomson, of greedily absorbing water. This they do in very large quantity, becoming like a wet glove; they are quite tender when wet. This water is, upon mere exposure, again given out, and *the specimen returns to the same state of hydration as before.*

The physical condition at this locality is solely that resembling cork. It is evidently here very pure; filaments may be stripped off, and the interior shows somewhat of a laminated structure, both in its more ready division into layers, and in its having a certain amount of that peculiar lustre which is seen on the glossy side of calves-skin. The colour is slightly yellower than that of rich cream.

It is somewhat sonorous when struck.

1·3 grammes yielded,

Silica	51·
Alumina	12·886
Ferric oxide	·094
Ferrous oxide	2·683
Manganous oxide	·076
Magnesia	7·538
Potash	·441
Soda	·265
Water	24 743
	99·726

Loss in bath 10·641 p.c. of the water.

5. The mode of its occurrence at the Tod Head in Kincardineshire is most peculiar.

This locality is on the geological horizon of one of the lower conglomerates of the Old Red Sandstone. In this locality these have been highly altered by interbedded sheets of amygdaloid, which are here clearly intrusive. This intrusion has occasioned frequent vertical rents in the stratified conglomerates, which rents cut through the imbedded pebbles, and the small amount of cement alike;—frequently shifting the two halves of the cut nodules.

In some localities wave action has on the coast removed the whole of the material which lay on one or other side of these cleavages, leaving a clean cut face studded with bisected nodules, fresh in appearance as when the rent cleft the rock. In other localities a rent which cuts from top to bottom a stratum forty to seventy feet in thickness, has its surfaces in such close approximation that the edge of a knife cannot be insinuated between them. While some remain gaping from a few inches to a foot and more apart, the chasm filled or not as the case may be with exfiltrated or injected matter.

At the promontory of the Tod Head itself there are instances of both of the above cases. At one spot a rent, which bisects conglomerate and amygdaloidal bed alike, is plugged up by injected close-grained but soft pale-green basalt.

A little north of this another rent is filled, though over a foot in width, with exuded calcite. In the very centre of this calcite there is a compound sheet consisting of mountain cork on one side, and of cyrstals of cockscomb-baryte on the other. The crystals of baryte have their free edges imbedded in the cork, so the latter was probably the last formed of the two.

The mineral here is intermediate in toughness and pliability between cork and leather, more resembling the latter however; it is nearly white in colour,—appearing merely slightly dirtied. It contains so much interstitial quartz grains and baryte that it was thrice picked and analysed before the results accorded with those obtained of specimens from other localities.

It was ultimately obtained pure by tearing it into shreds, which were gently beaten, till the grains of sand were dislodged from the fibres.

Of the *leather*, 17·3 grains yielded

Silica	52·483
Alumina	6·326
Ferric oxide	·6
Ferrous oxide	2·111
Manganous oxide	2·878
Lime	1·342
Magnesia	11·954
Water	21·702
	99·396

It lost in bath 5·995 per cent. of the water.

The fact that this vein of "leather" sometimes contains imbedded fragments of the conglomerate, seems to show that it has been formed by an exfiltrative process.

6. A specimen of the denser and more rigid variety yielded, on 25 grains.

Silica	51·606
Alumina	6·631
Ferrous oxide	2·702
Manganous oxide	2·77
Lime	1·113
Magnesia	10·811
Water	25·
	100·633

Loss in bath 9·27 per cent of the water.*

7. In the railway cutting not yet completed between Tay Port and New Port, on the south side of the Tay, I obtained the specimens next to be described.

The locality is about 200 yards west of the first of these ports.

The cutting was about 18 feet deep at the spot where the specimens were got, and the rock was perfectly firm and unaltered.

The rock is an amygdaloid with elongated steam-cavities of an inch or two in length, filled with pale green saponite; pear-shaped cavities filled either with agates or celadonite, and veins of calcite of about an inch in breadth and extending for many feet also occur. One side of these veins is sheathed with a variety of this mineral, which may be well described under the name of *rock silk*. Here the mineral is distinctly fibrous, the fibres being some inches in length; they are of extreme tenuity, generally disposed in parallel arrangement, and are rarely felted; they are highly lustrous, and pure white; occasionally passing into saponite green, or azure blue. The fibres are tough.

There being here no matting of the fibres, there are no free cavities, and the specific gravity is 2·108.

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*Two specimens as ordinarily occurring, that is not separated from included but almost invisible quartz grains,—yielded respectively.

Silica	66·026	...	63.384
Alumina	2·971		
Ferrous oxide	1·303		
Manganous oxide	1·383		
Lime	·645		
Magnesia	6·225		
Water	21·65	...	21·722
	100 203		
Loss in bath	5·045	...	6·112

1·201 grammes yielded,

Silica	54·371
Alumina	11·27
Ferric oxide	·212
Ferrous oxide	1·094
Manganous oxide	·333
Lime	·979
Magnesia	9·492
Water	22·407
	100·158

Loses in bath 9·259 per cent. of the water.

8. "From Lead hills." Such is the ticket attached to the next specimen I notice.

I found it in the collection of Mr. Jameson Torry, nephew of Professor Jameson, which collection I purchased.

As Mr. Jameson Torry collected most of his specimens with his own hands, I have every confidence in the correctness of the ticket.

The specimen was nearly white, very thin, very flexible and very tough. It seemed formed of matted fibres. It had a small portion of calcite attached.

19·8 grains yielded,

Silica	51·45
Alumina	7·981
Ferric oxide	·973
Ferrous oxide	3·286
Manganous oxide	1·487
Lime	1·97
Magnesia	10·15
Alkalies	traces
Water	21·7
	98·997

Loses 5·96 per cent. of the water in the bath; was probably contaminated with a little calcite, the carbonic acid of which may partly account for the loss.

The specimens I have of this substance from Strontian are, from its extreme levity, insufficient for analysis; they much resemble the Boyne leather, being, however, more flexible.

MOUNTAIN LEATHER.

	Loss in Bath.	$\ddot{Si}$	$\dddot{Al}_2$	$\dddot{Fe}_2$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Mg}$	H_2O	Total.
Strontian, (Thomson)...		51·65	9·51		5·81		10·01	2·07	21·7	100·73
Tod Head	5·995	52·48	6·33	·6	2·11	2 88	1·34	11·95	21·7	99·39
Lead Hills..... ...	5·96	51·45	7·98	·97	3·29	1·49	1·97	10·15	21·7	98·99
Boyne Burn	9·2	51·1	6·81	2·27	2·82	1·01	·86	10·16	23 9	98 93

MOUNTAIN CORK.

Portsoy	10·88	51·43	7·52	2·06	2·49	1·3	·58	9·35	25·04	99·76
Cabrach	10·64	51·	12·88	·09	2·68	·08		7·54	24 74	99·73
Tod Head	9·27	51·61	6·63		2·7	2·77	1·11	10·81	25·	100 63
Tay Port	9·26	54·37	11·27	·21	1·09	·33	·98	9·49	22·41	100 16

This tabulation shows the two varieties to be merely allomorphs of one and the same mineral.

In calculating the formula from the average of these analyses we obtain,

		Atoms.			
Silica.....	51·636..	1·7212	1·7212=9·724	..	10
Alumina	8·616..	·1673	·177	1·	.. 1
Ferric oxide ..	·776..	·0097			
Ferrous oxide ..	2 873..	·0800	·6649	3·756	.. 4
Manganous oxide.	1·407..	·0396			
Lime	·978..	·0349			
Magnesia	10·208..	·5104			
Water	23·275..	2·5860	2·5860	14·61	.. 15

This formulated becomes,

$$Al_2O_3,\ 2\,SiO_2 + 4\,(MgO,\ 2\,SiO_2) + 15\,H_2O.$$

Making alumina the sole sesquioxide, and magnesia the only protoxide, the number of molecules of water balances all the others.

This formula gives,

Silica	52·956
Alumina	9·092
Magnesia	14·122
Water	23·83

But the formula may be written generally $(RO,\ R_2O_3)\ 2\,SiO_2 + 3\,H_2O$, which is, with the exception of RO, the formula of halloysite; here, however, $\frac{4}{5}$ of RO are intruded, making the mineral stand, in chemical characters, between halloysite and Deweylite, but in physical features it is altogether different from either of the minerals.

It can, however, be no longer associated with asbestus or the hornblendes; and for the following reasons:—

Firstly. It is never associated with any one of the many allomorphic forms of that mineral.

We have found that the formations in which it occurs are,—granular limestone,—in this, though augite is common, the hornblendic type of mineral is very rare; in *veins* of granite,—a mode of occurrence in which hornblende at least is never found; in veins in Old Red Sandstone conglomerate,—in such an association hornblende has never been described; in veins in Silurian slates,—these do not carry asbestus or hornblende; and along with calcite in a metallic gangue.

Secondly. When the fibrous varieties of hornblende become altered, they are transmuted into serpentine; and, as I have shown in the Transactions of the Royal Society of Edinburgh, the change is brought about, after the removal of the lime, by the introduction of water and the abstraction of silica; but here the silica is in full amount. And, moreover, in the formation of serpentine from hornblendic minerals, by the time that

one half of the water here present has been introduced, the magnesia has proportionally increased to an amount three times as large as that which this mineral contains.

Lastly. I argue that this mineral is related neither to an unaltered asbestus, nor to the serpentine into which that substance might be transmuted, *in virtue of the peculiarity of its mode of holding a large part of its constitutional water.*

It will have been seen above that, as regards the water which they contain, the specimens from different localities would appear to divide themselves into two varieties, *leathers* and *corks*:—the leathers containing about 21·7 per cent. of water, of which they lose about 6 per cent. at 100°;—and the corks containing about 21 per cent. of water, of which they lose about 9 per cent. at the same temperature. But these varieties alike *regain the lost water speedily from an ordinarily moist atmosphere;* and they regain it *up to the due amount and no more.*

Hornblendic minerals never function in such a way; they may be said to contain none, and they care for none.

But as I shall in future papers show, the class of minerals among which its composition places this substance, seems generally to have its peculiarity of relationship to water, as a well-marked property.

This substance therefore would seem to stand altogether apart from the mineral of which it has hitherto been considered a mere hydrated allomorph. It must also be regarded as being possessed of well-marked and very distinctive physical properties. Specimens coming from different localities and diverse geologic formations have a closely accordant composition; and that composition is capable of being reduced to an unusually simple formulaic expression.

It must therefore be regarded as a "simple mineral," and be distinguished by a specific name.

From the *felted* character which has been noticed by all those who have described it, I propose for it the name of *pilolite* (πιλος felt.)

XIX.—*On the Celestine and Baryto-Celestine of Clifton.*

By J. N. Collie, Student of Chemistry at University College, Bristol.

Communicated by W. W. Stoddart, F.C.S.

DURING this autumn I had the opportunity of examining several different batches of celestine which had been dug out of the foundations of houses in this neighbourhood. On analysing one specimen which I took to be blue celestine, barium was found to be present in considerable quantities; I then made a more exact qualitative analysis but failed to detect calcium or any other metal. The mineral then obviously consists of a double sulphate of barium and strontium, and a mineral of that kind has been found by Thomson, and was called by him baryto-celestine. Baryto-celestine, so far as I can ascertain, has not, however, been previously found in the British Isles.

The quantitative analysis of the mineral seemed to me to be of especial interest to determine whether the two sulphates were present in such proportions as would enable the composition of the mineral to be expressed by a simple formula, or whether it consisted merely of a mixture in indefinite proportions of its two constituents.

The two sulphates are isomorphous, and isomorphous bodies as is well known can crystallize together in any proportion. On the other hand definite compounds of isomorphous bodies certainly occur in nature, for instance, dolomite, baryto-calcite, etc.

The analyses of my mineral gave the following results:—

	I.		II.
Barium	43·5	..	44·0
Strontium	12·4	..	11·8
Sulphuric Acid	43·4		
	99·3		

The formula $2\,BaSeO_4$, $SrSO_4$ would require

Barium	42·2
Strontium	13·2
Sulphuric Acid	44·6
	100·0

These numbers approximate each other, but are scarcely sufficiently near, even allowing for errors of experiment, for the assumption that the mineral is a definite compound in molecular proportions of the two sulphates, and must therefore be reckoned as an isomorphous mixture.

The matrix was of a light yellowish brown, and only slightly soluble in acids It contained silica, alumina, and traces of iron, manganese, and calcium.

Baryto-celestine seems to have been found only in three other localities; at Kingstown and Lake Erie in Canada, at Binnenthal in Switzerland, and at Hanover. Allied to it is a mineral from the chalk marls of Moen, containing barium, strontium, and calcium as sulphates, calcium carbonate and water.

The crystalline form of baryto-celestine seems to resemble celestine. It is radiating, columnar, and foliated, bluish white and friable, sp. gr. 3·9, and difficultly fusible to a white enamel. The angles appear to be identical with those of celestine.

Near the specimen I have just described I found embedded in the same matrix, but in a different lump, another quantity of what at first I took to be the same mineral: it was, however, more fibrous, and the crystals were not so well developed, the colour (faint blue) and general appearance were, however, much the same. The analysis of this specimen shows it to have a totally different composition. The numbers are,

Barium Sulphate	7·26
Strontium Sulphate	92·64

This led me to analyse some more specimens; the results are as follows:—

	I.	II.	III.
Barium Sulphate	10·9	4·2	1·2
Strontium Sulphate	89·1	95·8	98·8

From these results it would appear that Clifton celestine almost invariably contains sulphate of barium, but that the relative proportions of the two sulphates vary very considerably even in specimens of the mineral found within a few yards distance of each other.

The theory that it has been slowly deposited from aqueous solution would lead us to suspect that the sulphate of strontium would preponderate, as it is far more soluble than the sulphate of barium. The occurrence, however, of baryto-celestine, that is to say, of a mineral

containing such a large proportion of sulphate of barium, is remarkable, considering the fact that so much celestine occurs in the neighbourhood, and it can only be accounted for by assuming that the bed from which the sulphates were originally dissolved out contained a very large proportion of sulphate of barium as compared with sulphate of strontium.

XX.—*Crystals of Iron.*

By Amos Beardsley, F.L.S., F.G S., &c.

AT the General Meeting of the Society held at the rooms of the Royal Microscopical Society, King's College, London, on March 14th, 1877, were exhibited some octahedral crystals of iron, which were procured from a hollow cavity in the middle of a bar of pig iron. The way in which they came into my possession was this.

A friend was walking on the Docks at Liverpool some years ago, watching a vessel being unloaded, which had arrived freighted with pig iron from Gartsherrie. These pigs were lifted by cranes, and one accidentally slipped, and dropped on to its end, and was fractured in two pieces, showing a cavity about the size of a duck's egg, and his attention was drawn to some bright lustrous objects which he saw roll out of the cavity. These he at once picked up, and found they were crystals of the metal, octahedral in shape, and about $\frac{1}{8}$ of an inch in size.

All he could find were about 10, and of these 8 came into my possession.

I had shewn them to several persons interested in the manufacture of iron and steel, and thought they might be considered of some importance. However, they have been usually treated as being merely "curious;" at the same time I have never met with any one who has seen such crystals before.

I mentioned the fact to Mr. Collins, and he kindly exhibited them at the above meeting, and suggested that I should let him have one for analysis, which I readily consented to do, and the worth of this paper simply consists in recording such analysis.

Whether the crystallization depended solely on the composition, or partly upon the condition and circumstances in which they were found I cannot determine, but I think it is a fact which ought to be duly recorded, and one which may in some way or other be made practically useful in the manufacture of iron.

Mr. Collins, in his note to me says "I have at last finished the analysis of your crystal, and it is as follows:—

	Iron	93·50 p. c.
	Carbon	3·11
	Silica	1·35
Titanic acid....1·5 =	Titanium	·76
Phosphoric acid ·34 =	Phosphorus	·15
	Tin	·14
	Manganese	minute trace
	Loss (partly Carbon)	·99
		100·00

"The sp. gr. is only 6 665 in one trial and 6·667 in another; this is unusually low for *grey cast iron*, which is really what the crystals are.

"The material has considerable malleability.

"Grey cast iron often shews crystalline facets on being broken, but I have never met with complete crystals before. Meteoric iron, however, has been found crystallized in distinct octahedrons, but it usually contains nickel, of which I find none in these crystals."

Along with this analysis Mr. Collins also sent one of grey cast iron from Cleator, which is as follows:—

Iron	93·94
Carbon	4·18
Silica	1·92
Phosphorus	·08
Lime and sulphur	a trace

I have also been at some little trouble to my friends in procuring analyses of the various kinds of pig iron from different localities, if possible to ascertain wherein the difference consisted, and to what the crystallization might be owing, as no one individual to whom I have shewn them, nor any author I have consulted appear to have seen such before.

No analysis I have contains *Titanium*, besides these crystals, though I know it is found in the slag of furnace bottoms, and I have specimens obtained thence. Nor do I find *tin*; on the other hand *manganese* is only in minute trace.

I am indebted to my young friend, Mr. J. Smith, jun., of the Barrow Hæmatite Steel Co., for the following analyses, which may be useful for comparison.

Bessemer iron Nos. 1, 2, and 3, Barrow Hæmatite Steel Co., analysed by E. Richards.

	No. 1.	No. 2.	No. 3.
Carbon, graphite	3·25	2·96	2·81
,, combined	0·33	0·34	0·31
Silicon	3·04	3·02	2·97
Manganese	0·44	0·48	0·37
Sulphur	0·03	0·03	0·05
Phosphorus	0·01	0·02	0·02
Iron	92·90	93·15	93·47
	100·00	100·00	100·00

The mottled iron Barrow Hæmatite Steel Co., also analysed by Mr. E. Richards is

Carbon, graphite	1·455
,, combined	2·310
Silicon	0·847
Manganese	0·349
Sulphur	0·271
Phosphorus	0·024
Iron	94·744
	100·00

I also add some others from different parts of the country, which I give in the form of a table.

To these I may add the following:—

	Spiegeleisen, by the Krainische Co., analysed by E. Riley.	Ferro-Manganese by the Krainische Co., analysed by E. Riley.
Carbon, graphite	4·753	3·73
,, combined ..		2·
Silicon	·375	1·98
Manganese	18·215	44·98
Sulphur	trace	—
Phosphorus	·059	·22
Iron	76·361	43·83
	99·763	99·76

These crystals were formed in a hollow sphere of molten metal, which had gradually cooled down, and this may have influenced their formation.

Analysed by		Mr. Abel.	E. Riley.					T. H. Henery.		E. Riley.			T. H. Henery.	E. Richards.
Locality.		3 Foundry Pig. Hæmatite Iron Co., Whitehaven.	1 Grey Pig, Low Saw.	No. 1 Grey Pig, Butterly Iron Works, Derbyshire.	Goldendale Iron Works, North Staffordshire.	Foundry Pig, Netherton, South Staffordshire.	Grey Pig, Bowling Iron works, Yorkshire.	Grey Pig, Northamptonshire Ore.	No. 1 Pig, Forest of Dean Co., Park End Works.	No. 1, Weardale Pig.	Best Mine Pig, Dowlais, South Wales.	No. 4, Iron, Cleveland Pig, Bolckow, Vaughan & Co.	Pig Iron, Frodingham.	British Charcoal Iron, Harrison, Ainslie, & Co.	Swedish Iron, Brand OBA.
Carbon Graphite.....		2·30	2·795	3·35	2·54	3·07	2·99	0·610	3·26	3·24	3·10	3·9400	3·420	2·83	3·42
,, Combined ...		trace						1·440			·14				0·61
Silicon		2·72	4·414	1·27	2 71	1·48	0·97	2·980	2·34	1·80	2·16	1·7260	2·053	0·59	0·19
Manganese		trace	1·837	1·01	·98	·96		1·096	·23	1·45	·50	·6628	1·128		0·43
Sulphur		·05	0·039	0·02	·04	·03	0·05	0·197	·04	·04	·11	·0250	·048	0·03	trace
Phosphorus		·05	0·099	1·09	1·07	·43	0·50	0·936	·14	·19	Ni. ·05 Co. ·63	1·7807	1·338	0·10	0·04
Iron		94·88	90·584	93·26	92·66	94·03		92·727	93·99	93·28	94·56	91·8655	92·013		95·31
		100·00	99·768	100·00	100·00	100·00		99·986	100·00	100·00	100·00	100·0000	100·000		100·00

Whether they may be considered as only "curious," or whether they may lead to some investigation that may end in benefit to the manufacturer, they at any rate have a right to be recorded as one of the forms in which iron, either alone or combined, may be crystallized.

One of the crystals was submitted to that excellent crystallographer Dr. C. O. Trechmann, of Hartlepool, who remarks upon it as follows:

The crystal of iron which you had the kindness to send me, is certainly an interesting specimen, though I am afraid I shall not be able to give you anything towards its elucidation.

I believe that iron is generally recognised as crystallizing in the cubical system, since Wöhler (Pogg. Ann, 26, 112) described crystals obtained from large castings as skeletonized octahedrons of this system.

Your crystal seems to be a well-defined octahedron, in which the structure or aggregation is obscured by the large quantity of enclosed and attached impurites (plates of graphite).

Some years ago I found similar but smaller crystals (I have now lost them) in a casting, in which the manner of growth was beautifully displayed. They represented octahedrons with one elongated axis, and being quite skeletonized looked like small fir trees with two sets of branches at right angles to each other. The whole crystal seemed composed of bars which crossed and re-crossed at right angles and parallel to the fundamental axes. How the bars were constituted, whether built up of octahedral or cubical sub-individuals I am unable to say.

XXI.—*Note on the Banded Structure of certain Minerals.*

By. R. Cunnack.

Communicated by J. H. Collins, F.G.S.

DURING the past year some remarkably fine specimens of lithomarge, exhibiting in fracture a series of brownish striæ arranged concentrically about nuclei of tin ore, have been found at Wheal Coates Mine, St. Agnes, Cornwall.

A banded structure of this kind is commonly met with in minerals, but in this instance it occurs in such a manner as to suggest the mode of its formation, not only in this particular example, but in the denser substances quartz (agate) wood-tin, wood-iron, malachite, some forms of copper pyrites, &c.

In their normal condition rocks are saturated with moisture, and it is not difficult to conceive that any material capable of being taken into solution may be diffused through the most compact of these. In the course of this diffusion, if the particles of the solid substance have a greater attraction for those of the dissolved material than the latter have for their solvent, the result will be a precipitation of the dissolved material, which will be deposited in a shape dependable upon the direction and intensity of the attraction, and the direction in which the fluid moves; a continued deposition taking place towards the entering surface, and a slower solution going on at the opposite surface as each successive band is formed, the result of the continued action being a structure of the kind referred to.

Where the action is prolonged, a complete displacement of the original solid substance may take place, or the deposited material may accumulate to form a compact band, ultimately assuming a crystalline structure.

The large vein at Wheal Coates has long been celebrated for its tin pseudomorphs; but specimens taken at random from the neighbourhood from almost any ore deposit, show a tendency to a structure that suggests the idea whether a large portion of the contents of the veins themselves may not have been gathered together by a process similar to that alluded to: the agent being water on its way to the more porous portions of the veins, through which it finds vent to supply the

numerous perennial springs characteristic of a mineral bearing district. The "comby" structure so often noticed would thus be simply accounted for.

Viewed in this way the rock masses would be acting as huge dialyzers, separating crystalloid and colloid bodies in the way described by Professor Graham, and gradually yielding up matter originally interspersed throughout their mass, as it becomes capable of solution and diffusion through a solid substance by a change from a colloid to a crystalline slate.

It is noteworthy that stannic and silicic acids, which are both colloid when freshly prepared artificially, slowly assume, under certain conditions, a crystalline form.

Amorphous quartz is universally regarded by miners as an unfavourable indication for mineral riches, while the crystalline, or semi-crystalline form is looked upon as eminently propitious. The rich tin-stone now being raised at East Pool Mine affords very interesting characteristic examples of the process of change from the amorphous to a crystalline shape, the fractures showing imperfect hexagonal prisms in various stages.

Reviews and Notices.

Chapters on the Mineralogy of Scotland by Prof. Heddle.

Chapter III.—*The Garnets.*

MOST of the members of the Mineralogical Society are familiar with Dr. Heddle's "Chapters on the Mineralogy of Scotland," of which the first, dealing with the rhombohedral carbonates was read at the first meeting of the society after its formation, and the second on the Felspars was reviewed and copiously abstracted in the *Mineralogical Magazine*, No. 8.

We have now a third "Chapter," which deals almost exhaustively with the garnets, and begins as follows:

"Abundant as are the localities in which garnet is found in Scotland, there are but few which yield specimens such as can be analysed.

This is on account of an intermixture of quartz—for the most part in a granular form—the granules being promiscuously scattered throughout the mass of the crystals. In some localities the inter-mixture is not promiscuous but has been governed by some intermittent crystalline action. These localities are Glen Skiag, in Ross, where around a central nucleus of leucitoidal crystals of garnet, translucent quartz is arranged in layer which alternate with those of the garnet, conformably to the figure of its crystal.

The two other localities are the first and third granitic veins to the east of Portsoy; in both of which garnet of a pale brown colour is laced with quartz, which is arranged in a graphic manner as in the felspars from an adjacent vein."

Dr. Heddle then tells us that he has found the extremely rare *colourless garnets* (water-garnet) in a quarry on Creag Mohr, opposite to Balmoral, associated with the nearly equally rare *grossular*. The water garnet was a simple silicate of lime and alumina with no iron in either state of oxidation.

The grossular on the other hand, though pale in colour, contained as much as 15 per cent. of ferric oxide.

The lens-shaped masses were connected with one another through the continuity of their micaceous coating; forming what may be called a nodose vein,—the mica alone, however, truly constituted the vein;—the quartz, with its included minerals, assuming the nodose arrangement."

The occurrence of altogether *seven* varieties of garnet in Scotland is shown, and figures of the two singular arrangements of quartz, caught up in the act of crystallization, are given.

The occurrence of zircon in the two new localities in Ross Shire is incidentally mentioned.

The following table embodies the results of the analysis.

Cinnamonstone occurs in quantity both massive and crystallised, at Glen Gairn, in Aberdeenshire, as also of a less fine colour in some other quarries in the neighbourhood; and in a private communication Dr. Heddle informs the writer that he has lately found it in some quantity at the quarry of Ach na Gonolan, about 2 miles east of Grantown.

All the above garnets occur in granular limestone.

We are then presented with an analysis of the "Elie rubies," which at one time were frequently employed for purposes of jewellery in Scotland, and Dr. Heddle regards these as being still, weight for weight, the most valuable gem found in the country; we suppose, however, that he means of a minercal nature, and must except the magnificent pink pearls rarely obtained from the Scotch rivers.

Analyses of *common garnets* and of *almandite* from several localities follow; and lastly there is the description and analysis of the *manganesian variety* already noticed in our own pages.—*Mineralogical Magazine*, No. 9, p. 85.

In connection with this there occurs the following description of a singular granitic vein in a railway cutting near Strathpeffer.

"In carrying the railway through one of the ridges which run north and south in this small glen, a number of huge egg or lens-shaped masses were dislodged from the rock. These masses showed on their exterior a platey covering of glistening greenish mica. Their bulk necessitated their being broken up for removal; their interior was then seen to consist chiefly of quartz, plentifully studded in all directions with large and brilliant plates of mica, and garnets of very unusual beauty of colour.

"In addition, there was found, though in much smaller quantity, black and *green* tourmaline, rarely zircon, and still more rarely apatite.

	S.G.	$\ddot{Si}$	$\dddot{Al}_2$	$\dddot{Fe}_2$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Mg}$	H_2O	Total.
Grossular.										
Creag Mohr...	3·545	39·83	9·74	15·07	·11	·35	33·57	1·01	·05	99·73
Cinnamonstone.										
Glen Gairn		39·27	21·98	1·49	3·93	·33	31·88	·6	·18	99·66
Pyrope.										
Elie	4·124	40·92	22·45	5·46	8·11	·46	5·04	17·85	.1	100·39
Common Garnet.										
Burra Voe, Yell...	3·997	37·3	21·1	7·47	24·02	2·14	4·43	3·53		99·98
Killiecrankie	3·688	37·59	13·66	3·66	32·31	4·47	4·12	3·46	·32	99·59
Meall Luidh		37·7	14·8	4·56	32·97	2·37	5·89	1 81		100·05
Knock Hill	4·166	37·11	14·9	10·13	32·41	1·21	2·17	2·93		100·85
Almandite.										
Clach an Evin		39·93	19·81	13·69	13·29	1·	9·13	3·31		100·15
Precious Garnet.										
Glen Skiag, red	4·125	35·99	16·22	8·64	23·27	15·24	·4	·47	·25	100·48
Do. brown		36·08	18·96	7·03	21·56	13·62	1·77	·9	·33	100·29
Loch Garve	4·122	36·15	21·94	15·15	15·09	7·85	2 07	1·62	·31	100·16
Struay Bridge		35·66	15·8	13·12	22·21	11·43	1·12		·06	99·39
Ben Resipol...		36·85	21·24	7·38	18·38	14·46	·78	·85		99·92

Professor Heddle concludes a paper of twenty quarto pages as follows:—

"These analyses show the lime garnets to occur in primitive limestone; —the magnesian garnet in igneous rock; and common garnet in micaceous gneiss, and at one locality in diorite.

"The new manganesious variety is found in granitic veins, which lie in micaceous gneiss.

"The vein which carries garnet at Glen Skiag is probably the same which is seen at Struay Bridge; the similarity in appearance and composition of the garnets which occur in these veins may aid in identifying them.

"At one time I indulged the expectation that the occurrence of garnet in the limestones which are found towards the upper reaches of the Dee would enable us to follow out the bed or beds throughout the numerous and far-reaching windings to which they have been subjected. The two great beds of lime which course up the country from the east and west of Portsoy,—the westerly beneath, the easterly above the quartzite,—may without difficulty be traced until they approach the upper portions of the Don—into the vicinity in fact of the granite. Here, from a direct, they are suddenly thrown into a much winding course; and here they come into near proximity with an altogether different bed, which, with a general west and east trend, undulates down the valley of the Dee.

"To follow out their relationships, and even to determine their identity in this highly disturbed district, is a problem of much difficulty.

"If it could be proved that the garnet was confined to one bed—that in which it first appears to the westward on the slopes of Leach Ghorm, and which can be clearly traced to Creag Mohr,—then it must be held that this bed takes a sudden sweep to the northward, and is that which, with a westerly dip, is seen in Glen Gairn. It must also be held that it is this same bed which, having formed an anticline—now denuded off—reappears with an easterly dip at Crathie, and crossing the river at Boultshoch, is again seen at Corn Tullich,—henceforth holding an almost rectilinear course as far at least as Eslie.

"The localities at which this *west and east* bed is to be seen are—Leach Ghorm; near Carn-na-Cuimhne; on the south of the Dee in the Balmoral Park; on Creag Mohr; at Boultshoch; at Corn Tullich; in Knappy Park at Aboyne; at Craigs, Muir, Mid-strath and Wood Cottage, in Birse; west of Arbeadie, Banchory; on the Aberdeen road near Banchory; east of uFegh Bridge; and in three or four spots on the Hill of Tilquibillie. That only one bed appears at all these spots may however be doubted.

"But it is probably as correct a view to hold that the limestones become garnetiferous when they are approached by the granite, or become par-

tially at least involved in that process, which in their near neighbourhood resulted in granitic formation. If so, the Glen Gairn, if not also the Craithie lime, must be regarded as the continuation of the great north and south bed last seen in the neighbourhood of Tornahaish.

"It is to be looked for that the occurrence of the garnet may aid in the determination of the true position of the limestones in this troubled district."

ON SOME POINTS IN LITHOLOGY.—By Jas. D. Dana.—Under this title an important paper has appeared in the *Am. Journ. Sci.* for November and December, 1878. The author concludes his paper as follows:—

1. The necessities of the science of Geology constitute the most prominent motive for distinguishing *kinds* of rocks; and they should determine to a large extent upon what characters distinctions should be based.

2. In determining the rocks to be grouped as one in *kind* under a common name, near identity in the chemical and mineral composition of the chief constituents is the main point to be considered; not near identity in their crystalline forms, for isomorphism presupposes diversity of composition.

3. Distinction of *kind* should be based on difference in chemical and mineral constitution as regards the chief constituents. When such difference exists, rocks are different in *kind*, and need, for the purposes of geology, distinct names. If it does not exist, the distinction is only that of *variety;* unless (as in the case of trachyte and felsyte), the very wide extension of the rock under persistent characters makes a distinction of name important to geology.

4. It follows from the preceding, that differences in texture: as coarse, or fine, or aphanitic; porphyritic, or non-porphyritic; stony throughout, or having unindividualized portions among the stony grains; and differences in microscopic inclusions; are no basis for a distinction of *kind* among rocks, but only of *variety;* and that *porphyritic structure* is of hardly more consequence than coarse or fine granular.

5. No marked change in the constituents of the earth's erupted material occurred after the close of the Cretaceous period, or just before the commencent of the Tertiary era; and, hence, no ground exists for the distinction of "older" and "younger" among eruptive rocks. The "younger" eruptive rocks are essentially like the "older" in chemical composition and their chief mineral constituents; and they

differ when at all only in texture and some other points of as little importance—qualities that distinguish merely varieties, and which have proceeded from greater prevalence in these later times of sub-aerial eruptions.

6. Since "plagioclase" is not the name of a mineral species,—several minerals, of widely different compositions being embraced under it—it is a confounding of differences and resemblances to speak of it as a constituent of a rock. And since it now includes, through the defining of the feldspar microcline, a large part of potash feldspar, which had been supposed to be orthoclase, it has become almost synonymous with the term feldspar. The "simplicity" its adoption has been supposed to give to lithological system would be greater if "feldspar" were substituted, and with its present range of constitution, the evil would be hardly less.

7. Rocks differing mineralogically, and not chemically, like related hornblendic and augitic rocks (the minerals hornblende and augite being dimorphous), are rightly made distinct rocks, since the difference has depended, to a large extent, on wide-reaching geological operations or conditions, and is, therefore, of great geological significance.

8. Since quartz is the most widely distributed and therefore the least distinctive of the minerals of rocks, it may rightly be regarded as of subordinate importance in the distinguishing of rocks, and hence not only such names as *dioryte* and *quartz-dioryte*, *trachyte* and *quartz-trachyte*, etc., are acceptable, but *syenyte* and *quartz-syenyte*.

9. Biotite being closely like muscovite in composition, and not less common than it in granites, gneisses and mica schists, and being, moreover, unlike the mineral hornblende in chemical constitution and formula, the rocks in which biotite is a chief constituent cannot rightly be put in the same group with hornblende rocks, or those in which hornblende is a chief constituent in a group of mica-bearing rocks. Consequently the name "mica-dioryte," for a rock containing no hornblende, and the name "hornblende-granite" for a rock containing no mica but hornblende instead, imply alike false relations.

The discussion suggests the following additional remark:

The incapabilities of the microscope and polariscope have favored the use of the term "plagioclase," and have led some investigators to overlook or slight distinctions in chemical constitution. Lithology is to receive hereafter its greatest advances through chemical analyses; for chemistry alone can clear away the doubts the microscope leaves, and so give that completeness to the Science of Rocks which geology requires for right and comprehensive conclusions.

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Moreover the researches made in the laboratory to be of real geological value should be, if possible, supplemented by investigations in the field as to transitions among the rocks, and as to other kinds of relations. This field work has often been well done, but not so by all lithological investigators.

The principles presented lead to the following subdivisions in an arrangement of crystalline rocks, exclusive of the Calcareous and Quartzose kinds. Since leucite is a potash-alumina silicate, like orthoclase and microcline (it affording twenty per cent. or more of potash), it is here referred to the same group with the potash feldspars; and nephelite, sodalite and the saussurites being eminently soda-bearing species, they are included with the soda-lime feldspars (anorthite to albite). This reference for lithological purposes of these minerals is sustained by their resemblance to the feldspars in constituents, and also in the quantivalent ratios between the alkalies, alumina and silica; this ratio being in leucite 1 : 3 : 8, as in andesite, and in sodalite and nephelite 1 : 3 : 4, as in anorthite. The term *potash feldspar*, as used in the headings below, is hence to be understood as covering orthoclase, microcline and leucite; and *soda-lime feldspar*, as including the triclinic feldspars from anorthite to albite, and also nephelite, sodalite and the saussurites.

The arrangement is as follows. In the first series, the rocks graduate into kinds which are all feldspar, and into others that are all mica; and yet the amount of potash present is approximately the same.

I. *The Mica and Potash Feldspar Series:* including Granite, Granulyte, Gneiss, Protogine, Mica-schist, etc., Felsyte, Trachyte, etc., and the Leucite rock of Wyoming.

II. *The Mica and Soda-Lime Feldspar Series:* including Kersantite, Kinzigite; and the nephelitic kinds Miascyte, Ditroyte, Phonolyte, etc. (These nephelitic kinds belong almost as well in the preceding series).

III. *The Hornblende and Potash Feldspar Series:* including Syenyte (with Quartz-syenyte), Syenyte-gneiss, Hornblende schist, Amphibolyte, Unakyte (this last containing epidote in place of hornblende); and the nephelitic species Zircon-Syenyte, Foyayte.

IV. *The Hornblende and Soda-Lime Feldspar Series:* including Dioryte (with Propylyte), Andesyte, Labradioryte (or Labrador-dioryte), etc., and the saussurite rock, Euphotide.

V. *The Pyroxene and Potash Feldspar Series*: including Amphigenyte.

VI. *The Pyroxene and Soda-Lime Feldspar Series:* including Augite-Andesyte, Noryte (Hypersthenyte and Gabbro in part), Hypersthenyte

(containing true hypersthene), Doleryte (comprising Basalt and Diabase), Nephelinyte, etc.

VII. *Pyroxene, Garnet, Epidote and Chrysolite Rocks containing little or no Feldspar:* including Pyroxenyte, Lherzolyte, Garnetyte (Garnet rock), Eclogyte, Epidosyte, Chrysolyte or Dunyte (Chrysolyte rock), etc.

VIII. *Hydrous Magnesian and Aluminous Rocks, containing little or no Feldspar:* including Chloryte schist, Talcose schist, Serpentine, Ophiolyte, Pyrophyllite schist, etc.

Iodobromite: Professor Von Lasaulx's new species.—It is well known that the chloride and bromide of silver occurs associated in the species Embolite. No specimen of embolite, however, has hitherto been found to contain iodide. In fact the iodide, as Iodyrite, crystallizes in the hexagonal system, while Bromyrite and Cerargyrite are isometric. Hence it was hardly to be expected that the three haloids would be found crystallized together in the same mineral. Yet this is what actually occurs in the new species which Prof. Von Lasaulx has lately described under the name of *Iodobromite*. A combination of chloride, bromide and iodide of silver here crystallizes in regular octohedra. It should be noted, however, that Herr O. Lehmann has recently obtained artificially a monometric modification of iodide of silver; and indeed the existence of many cubic iodides, isomorphous with the corresponding chlorides and bromides, has prepared us for the occurrence of native argentic iodide in forms belonging to the regular sytem.

The new mineral, Iodobromite occurs at the mine called "Schöne Aussicht," near Dernbach in Nassau—a mine which has already yielded some notable minerals, such as Beudantite and Scorodite, but which has not heretofore furnished any argentiferous species. In the cavities of the iron-shot quartz in this lode, the iodobromite occurs in the form of minute crystals, which are sharply defined regular octahedra. The faces are perfectly smooth and brilliant in the smaller crystals, but drusy in the larger ones. Occasionally the cube is found in combination with the octahedron; and its faces are characterised by their adamantine lustre. On one crystal an icositetrahedron was observed. Feeble indications of octahedral cleavage have been obtained.

The crystals are of sulphur-yellow colour, showing in some cases a transition to olive-green. Like the other haloid salts of silver, the mineral is very sectile, and may be readily flattened-out under a knife. Fused with bisulphate of potash, the hot bead shews an intense garnet-red colour, which passes into orange and yellow on cooling. On

charcoal before the blowpipe it is reduced to a globule of metallic silver, with evolution of fumes of bromine.

Iodobromite has a specific gravity at 18° C. of 5·713. Only 0·5720 gram. could be used for analysis.

The analysis yielded :—

Silver	59·96
Iodide	15·05
Bromine	17·30
Chlorine	7·09
	99·40

These figures lead to the formula

$$2\,Ag\,(Cl, Br) + Ag\,I.$$

(Abridged from the author's separate copy from the *Neues Jahrbuch für Mineralogie.*)

F. W. R.

FURTHER RESEARCHES ON THE SUPPOSED SUBSTITUTION OF ZINC FOR MAGNESIUM IN MINERALS.—By Edward T. Hardman, F.C.S., &c., Geological Survey of Ireland. (*Proc. Roy. Irish Acad.* for 1878.)

In all but one or two cases the analysis was twofold. First, an examination with the blowpipe was made, and then if zinc was indicated, a complete analysis in the wet way.

There is one point worth mentioning, however, in this connexion. It appears to be usually the impression that the only reliable blowpipe tests for zinc are the white incrustation, and the green colour imparted by nitrate of cobalt; and that it is too volatile to be reduced to the metallic state on charcoal. Such appears to be the idea on which are based the directions for its detection, in many books on Chemical Analysis, or special works on the blowpipe, but it is an erroneous one, for with care the metal is easily reducible. With less than half a grain of mineral, containing a mere trace of zinc, fused on one of Griffin's reduction pastilles, I have obtained sufficient of the metal to apply the most characteristic wet tests, and such as could leave no doubt as to the nature of it; while with large capsules, and a properly managed reducing flame, the feat is perfectly easy with larger quantities.

The following list gives the principal specimens in which I have found zinc :—

(1). *Talc schist* from the sea shore, Mullaghglass, county Galway.

(2). *Hornblende.*—Crystals from the above.

(3). *Dark-green Serpentine* from N. slope of Croagh Patrick Mountain, county Mayo.

(4). *Flesh-coloured Dolomite* from the carboniferous limestone of Ballyfoyle, near Kilkenny.

(5). *Dolomite* from Ballyfoyle, similar to above.

(6). *Dolomite* from Clara, near Kilkenny, similar to the above.

(7). *Very compact Crystalline Magnesian Limestone* from Tawnagh, Toormakeady, county Mayo.

(8). *Hornblende Schist* from Inish-gloria Island, Belmullet, county Mayo.

(9). *Hornblende Rock* from Annagh Head, Belmullet.

(10). *Very pure Talc* from county Galway.

(11). *Black Mica* from a vein in the summit of Liss-oughter, county Galway.

(12). *Orthoclase Felspar* from a felstone porphyry, county Mayo.

(13). *Hornblendic Epidotic Rock* containing numerous radiated nests of *Actinolite* or *Tremolite*, from Cannaver Island, Lough Corrib.

(14). *A Serpentine Rock* from N. W. slope of Croagh Patrick, county Mayo.

(15). *Chlorite* from a granite from Limehill, near Pomeroy, county Tyrone.

(16). *A dark graphitoidal steatitic Argillite* from county Mayo.

(17). *Very pure greenish Steatite* from county Mayo.

(18). *Talc Rock* from Crohy Head, county Donegal.

(19). *Iron Pyrites* from county Donegal.

(20). *Actinolite Rock* from Cannaver Island, Lough Corrib. Similar to No. 13.

(21). *Serpentine* from Liss-oughter, county Galway.

What I wish to urge upon your attention, as the result of these investigations, is the almost invariable occurrence of zinc in the minerals examined. I have already shown that the presence of zinc as an accessory component of minerals has been almost entirely neglected—in fact it is only mentioned where it occurs in considerable quantity, as in Franklinite or Automolite; and so uncommon is it looked on as an accessory, that the only augite in which its presence has been recorded before I had commenced this research was dignified with a special name—Jeffersonite.

When a metal not usually occurring in rocks in any large quantity is recorded, it is usually because it exceptionally occurs so abundantly that its presence cannot well be overlooked; and it is only in such

cases that zinc has been hitherto observed. It appears, however, that, like many other substances, it only requires to be sought after; and that its presence is not simply accidental, but the result of the invariable chemical laws of affinity and isomorphism; and I submit that zinc is as much to be regarded as an almost constant associate of the magnesium group as indium and osmium with platinum; niobium with tantalum; rhuthenium and rhodium with palladium, and so on.

In all the instances I have noted in this and my former Paper, the quantity of zinc is small; but this again is really in favour of my view. Had the metal occurred in large quantity in portions of the rock, we should be entitled to consider its presence accidental; but its occurrence in small amount, and its being generally diffused in the rock or mineral, proves it to be truly a constituent.

A lode or thick deposit of zinc ore would be an accidental deposit; but it is from the infinitesimal quantities of this metal disseminated throughout rocks that workable accumulations are derived. As Bischof remarks, the minimum of a mineral in rocks becomes the maximum in lodes; and, although the small traces of zinc in the specimens given above may appear insignificant, it must be remembered that a knowledge of the fact of the diffusion of minute quantities of the metallic compounds through rocks leads to a correct notion of the formation of mineral veins, as otherwise we should be compelled to regard them as exotic productions, derived from unknown sources.

Petroleum of Marmarosch (extreme N. E. Hungary.)—Dr. E. Tietze (*Imperial Geological Institute Report*, September 30th, 1878. Communicated by Count Marechall.)

Near Dragomir, on the S. side of the river Zea, the *Miocene* Rock-salt Formation appears in its full typical form, as on the N. margin of the Carpathians, where the Galician petroleum-springs exist. Trachytic tuffs and green stone are met with in isolated patches in it. The petroleum is subordinate to the rock-salt formation, not to the trachytes. There is no sufficient reason to consider the "grey clays," to which the naphtha-springs belong, as being the emanations of mud-volcanoes. These light-grey clays are associated to sandy-argillaceous marls with subordinate gypsum and thin layers of a soft, bluish-gray, somewhat micaceous, sandstone. At one place, shales, resembling menilite, appear suddenly. They are thin lamellated, brittle, with the surface of the lamellæ coloured whitish or yellow by decomposition, and evidently intercalated with the rock-salt formation. Similar shales exist in the same formation near Delatyn (Galicia). The rock-salt formation near Dragomir strikes W.N.W. to E.S.E., and dips N. and

N.E. A slight folding occasions a merely local S. dip. In the higher S. horizon of the mountain-range, yellowish, rather fine-grained, somewhat micaceous Carpathian sandstones are met with. They are of *Eocene* age, as ascertained by MM. Fr. de Hauer and Baron Richthofen. The rock-salt formation, keeping its strike, appears again on the S. side of the valley. It is rather abundantly impregnated with hydrocarburets, coming to day-light at a little depth beneath the alluvial gravel in the bed of the river Iza. A shaft, sunk to 162 feet depth, gave a certain quantity of petroleum of middle quality, and in greater depth, water much impregnated with salt, which is considered a rather promising indication. In another place, a certain amount of *Ozokerite* has been found in a depth of 204 feet. *Brown coal* appears only in traces not worth exploitation. Silicified *stems* of *trees* and a *cold spring*, strongly hydro-sulphuretted are found in the rock-salt formation. This last is quite unconnected with the trachytes in its vicinity.

Crystallogenesis, by Chevalier de Hauer (continued).—(*Imperial Geolog. Institute Report*, September 30th, 1878. Communicated by Count Marechall.)

Sulphate of Magnesia.—Crystals having regular terminal surfaces can only be obtained from the solution of this salt, as long as their size remains very moderate. This regularity is only perceivable on the first-formed individualized crystals by refrigeration of a hot solution, or by spontaneous evaporation of an incomplete saturation. Such crystals, especially those obtained by evaporation, are occasionally of correct form at the end in contact with the surface of the solution.

It is absolutely impossible to obtain a complete regular evolution of the crystals by turning them repeatedly, or by suspending them in the solution. As these crystals increase in volume, their terminations become more abnormal, the prismatic surfaces remaining regular. The terminal surfaces of the rhombic prisms disappear and are superseded by cavities and other irregularities, the individual type being thus completely lost, even when the utmost caution is taken to make the process of increase go on slowly and without disturbance. Under these circumstances, sulphate of magnesia must be ranked among the substances possessing a feeble intensity of crystallizing power.

All these circumstances change suddenly by the introduction of a slight proportion of a solution from *Borax* into the solution of sulphate of magnesia. The crystals issuing of such a solution are so different in their physical characters from those of un-mixed sulphate of magnesia, that they can only be identified with them by means of their angles. They offer the form of short and thick prisms, while those

from un-mixed solutions are lengthened or acicular; they are also more pellucid, harder, and probably more compact. They chiefly differ from those of pure sulphate of magnesia by the perfection of their form, the terminal surfaces of these last being invariably disfigured or mutilated. Crystals from a solution of sulphate of magnesia have grown to the diameter of several inches without any alteration of form. Even, crystals purposely mutilated, when plunged into a solution containing borax, are soon completed; obtaining surfaces previously non-existant, or existant ones of greater extension. Crystals of pure sulphate of magnesia frequently are fissured through their mass. When increasing in a solution with borax, these fissures are not continued into the new deposit, which, at the same time, shows more pellucidity and a more homogeneous aggregation of substance. Crystals from a pure solution, being a mere shapeless aggregation of individuals, when immersed into a solution with borax, are surrounded with a crystalline crust, hiding all their irregularity, and thus are transformed into beautifully perfect crystals.

The crystals of sulphate of magnesia, obtained in the manufactures at Stassfurt, surpass in perfection all those obtained in laboratories, and show all the characters of those issuing from a solution mixed with borax. The quantity of solution, out of which these crystals issue, may account for their size, but not for their perfection, as, when plunged into a solution of pure sulphate of magnesia, they lose their regularity, as they increase in volume, while, in a solution mixed with borax, their perfection is not lost nor altered as their volume augments.

A mixture of *Sulphate and Chromate of Magnesia* gives crystals more and more imperfect as they increase in size. An addition of borax is sufficient to obtain perfect crystals. If, to compensate the loss of solvent, saturated solution of pure sulphate of magnesia is repeatedly added, the perfection of the crystals remains unaltered, in whatever quantity they may be obtained.

A chemical combination of borax with sulphate of magnesia may scarcely be admitted, chemical analysis having proved, that only minute particles are included mechanically in the crystallized sulphate of magnesia.

Sulphate of Soda acts as favourably as borax on the crystallization of sulphate of magnesia. Possibly, the perfection of the crystals obtained at Stassfurt may be due to their materials containing a certain proportion of sulphate of soda.

Sulphate of magnesia, mixed in any proportion with *sulphate of nickel*, which is isomorphous with it, is crystallizable. The same is

the case with *sulphate of cobalt*, although this last is not isomorphous with it. The isomorphous combinations of sulphate of magnesia with those of nickel, cobalt and chromium give rise by superposition to uncommonly beautiful crystals. Their form becomes perfect by plunging them, at last, in a solution of sulphate of magnesia with admixture of borax. Care must be taken to avoid the immediate contact of the crystals, containing nickel or cobalt, with the solution of sulpho-chromate of magnesia, before a stratum of sulphate of magnesia has been deposited on their surface, else the purity of the crystals might be altered by formation of a small proportion of chromate of nickel or of cobalt. All these crystals, when increasing within a solution of sulphate or of sulpho-chromate of magnesia, containing borax, gradually adopt the above-mentioned typical form of thickened prisms. Immediately after the first formation of crystals in a solution of sulphate of magnesia, this type prevails so much, that the surfaces of the prisms are almost completely wanting. The most perfect crystals of *sulpho-chromate of magnesia* are obtained by letting them increase in the pure solution, and then immersing them in a solution of borax. The crystals, issuing from the pure solution are affected, as they increase in volume, with the same imperfections as those of sulphate of magnesia.

Derivations of the Sulphate of Magnesia and Iron.—These sulphates crystallize in various proportions of quantitative mixture, and show the form of sulphate of iron, with a less number of surfaces. This double combination crystallizes, without alteration of form, when mixed in very variable proportion with sulphates of zinc, nickel, cobalt, copper, manganese and more complicated mixtures of these all. The crystals, thus obtained, offer an admirable variety of colours and forms. However, among hundreds of them, not one of them has been found offering an equal number of surfaces to sulphate of iron. Whenever a crystal of sulphate of iron is left to increase in a solution of one of the above-mentioned mixtures, some of its surfaces soon disappear. Sulphates of magnesia or zinc being added to the saturated solutions of these mixtures, in such quantities as they may still be dissolved, these solutions become saturated with respect to the crystals of each of these combined mixtures.

The whole of the mixtures of sulphate of magnesia and of iron with other sulphates may be obtained in superposition to each other in any desired order of succession. When carefully managed, these crystals keep their pellucidity, thus offering an uncommon variety of coloration, chiefly due to the little difference of solubility between these mixtures. The mixture of *sulphate of copper* with those of iron,

zinc, cobalt or nickel, in nearly equal proportion, at first constantly give rise to triclinal crystals of sulphate of copper (as proved by Professor *Rammelsberg*) with a very slight admixture of the second substance. The subsequent crystals have the same form as those of sulphate of iron.

The crystals issuing from these mixtures are generally of still simpler form than those from a mixture of sulphate of iron and of magnesia, so that the crystallographical system into which they are to be ranked, cannot be certainly ascertained. According to *Dr. Brezina's* measurements, they may be admitted to be triclinal. The same crystals, immered into a solution of the sulphates of magnesia and iron, continue to increase; consequently they are isomorphous with those of sulphate of iron. Solutions of *sulphate of manganese*, mixed with those of the sulphates of magnesia, cobalt, nickel and zinc, so that the first of these solutions prevails, give crystals of the same form as those of sulphate of iron, differing only in "habit," especially those of a mixture of sulphates of magnesia and manganese. The crystals, different in chemical composition, issuing from the various mixtures of sulphates, may be divided into three groups, whose terms are isomorphous to each other, although the terms of each group offer a common peculiar "habit" which is not to be met with in the two other groups. If a crystal is left to increase in a solution of a crystal of a different group, it gradually assumes the type of the dissolved one. The same takes place in other isomorphous groups; a proof that the "habit" of the form, and certain aberrations from the strictly geometrical form are in no way merely fortuitous. Mixed crystals from two terms of these three groups, offer, in some cases, intermediate forms; occasionally the type of one of the two groups becomes prevalent, whatever may be the quantitative proportions of the mixture.

All the combinations, issuing from mixtures of sulphates, possess an intense power of crystallization. Even, when increased to a very notable volume, their crystals are perfect in form, and pellucid; they resist better the action of air (and those containing iron) are less oxidizable than sulphate of iron.

Meteoric Fall at Dhulia (Hindustan)—Dr. A. BREZINA. *(Vienna Imperial Academy Meeting*, November 7th, 1878. Communicated by Count Marechall.)—This fall took place in November, 1877, at 6 p.m. A fiery globe, of the size of a hen's egg, was seen in S. about 50° above the horizon, slowly advancing westward and gradually notably increasing in size. The light, at first similar to a light-

blue signal-light, became light-red and as intense as day-light. The globe, having disappeared, left a luminous trace, first distinctly limited, then gradually dissolving into an indistinct nebulosity. Six or seven minutes (an interval very probably much over-rated) after the meteor had come to its maximum of luminous intensity, a noise like slow thunder was perceived. The altitude of the meteor above the soil is estimated, although without certitude, at between 80 and 100 miles. The meteorite has been analysed at Bombay; its constituents are: nickeliferous iron and magnetic pyrites, 32·62 p.c.; mechanically aggregated silicates, 69·38 p.c. These silicates are composed of silica, 34·73; magnesia, 24·17; oxide of iron and alumia, 6·66; lime, 3·82. The quotient of oxygen being equal to 38, and the proportion of lime being rather considerable, this meteorite is to be considered as an aggregation of peridot with pyroxene, slightly calciferous, in which the first constituent prevails. No trace of carbonous substance has been found.

Felspars.—Professor Joseph Szabo of Budapest, in a letter to Prof. Heddle, in which he discusses the conclusions arrived at in the monogram on the Felspars, lately reviewed in this Journal, remarks,—

"Your conclusion is for me very interesting, because I came, some five years ago, to the same result, as regards the tertiary and some of the older eruptive rocks; the felspars are in their association very constant.

"The term plagioclase must be abandoned, and the special name of the plagioclase is to be used.

"For the determination of a felspathic rock the species of the felspar must be known. Of all the constituting minerals it is the felspar which is the most essential, and in many cases through the felspar the rock itself is determined.

"As regards the eruptive rocks belonging to the same cycles of eruption,—for instance as regards the tertiary trachytes of Hungary and the adjacent countries to the south of Europe, where the beginning and the end of the eruption is well-known, I came even to the conclusion, that the felspars indicate also the relative age of the respective rocks.

The products of the last trachytic eruptions contain anorthite; the first eruption was a trachyte with most acid-potash-felspar, and so came successively the oligoclase, labradorite, and at last the anorthitic lavas.

"I have established a method of determining the felspars even in the rocks. The *American Journal of Science* gives a description of it (1877).

There exist now three methods of determining the felspars,—

a. The optical methods of Descloizeaux.

b. The method of the flame-reactions (Szabo's).

c. The method of Boricky (Prague) by converting the felspars into fluo-silicate combinations and observing their different forms of crystallization.

"I use them all, but in most cases it is my method which gives the surest and the quickest results. In some cases the other methods are preferable."

Professor Szabo is to carry out a new set of observations upon the series of specimens which were analysed by Professor Heddle.

J. H. C.

Specific Gravity of Rocks from Finland.—By Dr. F. J. Wiik.—(*Proceed. Imper. Geol. Instit. Vienna*, January, 1878.)

Gneissic, porphyritic, and syenitic granite..	2·580..2·736
Compact diabase, with long acicular crystals of apatite, forming a vein near Sordawola	2·742..2·746
Peridot of diabase, breaking through the granite of West Finland, and found in loose fragments on the island of Aland ..	3·100
Peridotic gabbro, from Tisrois	2·862
Peridotic diorite, from Kurn.....	3·161
Diabase of Kristmestadt	3·014
Gabbro from Heinola.....	2·949
Dioritic porphyry, from Berthula.....	2·925
Uralitic porphyry, from Hattula	3·015
Diorite, from Idensalmi.....	3·129

Elæolithic syenite, Iiwaare, in Kuusamo, holds an intermediate place between the acid and the basic rocks; and is allied to the orthoclase-elæolithic rocks from Portugal (foynite), and from the Urals (miascite), &c.

T. R. J.

Tellurium Ores of Transylvania.—By A. Schrauf.—*(Imper. Geol. Insti., Vienna, Report,* August 31, 1878.)

These ores are Sylvanite (ascertained to belong to the monoclinic system), white tellurium ore (krennerite), nagyagite, and the tellurets of silver, distinguishable into species—hessite, (silver-tellurium-glance) of the tesseral crystalline form, isomorphous argentite, and a new species, stutzite (tellurium-silver-blende) isomorphous with discrazite and copper-glance. The new species is only known by a unique specimen, probably from Nagyàg, and preserved in the museum of the Vienna University.

The analysis of a very minute quantity exhibits a chemical composition expresed by the formula, Ag_4 Te.

T. R. J.

Hullite.—A short notice of this mineral appeared in the *Min. Mag.*, No. 10. It has since been fully described by Mr. E. T. Hardman, F.C.S., and Prof. Hull in the *Proceedings of the Royal Irish Academy*, Nov., 1878.

Analysis by Mr. E. T. Hardman,

Silica	39·437
Alumina	10·350
Peroxide of iron	20·720
Protoxide of iron	3·699
Protoxide of manganese	trace
Lime	4·484
Magnesia	7·474
Water	13·618
Carbonic acid	trace
	99·782
Sp. Gr.	1·76

The author calls attention to its very low specific gravity, and regards it as a ferruginous chlorite near *delessite.*

Probable formuala—

$$(Cu\ Mg\ Fe'')3\ (Al''\ Fe''')_4\ Si_6\ O_{21} + 7\ H_2\ O$$

Microscopic appearance (by Prof. Hull).—With 25 diameters the rock in which it occurs is seen to consist of light-brown amorphous augite with short prisms of plagioclase, imperfect crystals of olivine, and a very few grains of magnetite enclosed in the new mineral. This is

dark umber-brown, almost opaque except at edges—does not polarize. With a high power shews stalagmitic or chalcedonic structure, with wavy bands. Is apparently a secondary mineral.

SZABOITE.—*Am. Journ. Sci.*, Nov., 1878),—Occurs in minute exceedingly thin triclinic crystals—much like pyroxene; H = 6 and above, G = 3·505; hair-brown to hyacinth red—opaque to translucent.

$Si O_2$	52·35
$Fe_2 O_3$	44·70
$Al_2 O_3$	trace
Cu O	3·12
Mg O	trace
$Na_2 O$	trace
Ignition	·40

Is more or less closely related to babingtonite.

J. H. C.

PSEUDOBROOKITE.—(*Am. Journ. Sci.*, Nov., 1878.)—Minute tabular rhombic crystals; distinct brachy-diagonal cleavage, H = 6, G = 4·98; dark-brown to iron-black, thinnest crystals brown to red; translucent; lustre adamantine.

$Ti O_2$	= 52·74
$Fe_2 O_3$	42·29
$Al_2 O_3$	trace
Cu O Mg O	4·28
Ignition	·70

Like manaccanite, but differs in crystalline form.

J. H. C.

STUTZITE.—(*Schrauf. Zeitschrift für Kryst.*, II, 245.)—Lead-gray highly-modified oblique crystals with hexagonal habit, on gold, from Transylvania. Composition nearly $Ag_4 Te$ = tellurium 22·5, silver, 77·5. Form "closely related to that of dyscrasite and chalcosite."

J. H. C.

GRAPHIC GRANITE.—Mr. F. Johnson has recently found this on waste heaps at South Crofty Mine, near Redruth.

J. H. C.

Thaumasite. (*Comptes Rendus des Séances de l' Academie des Sciènces, Paris, tom.* 87, 1878, *p.* 313.) Prof. Nordenskiöld communicates a note through Prof. Daubrée to the French Academy of Sciences, upon a mineral having a remarkable composition which has been found in Gustav and Carlberg, or Bjelke mines, Areskustan, Sweden. Specimens obtained in 1859 by Prof. Nordenskiöld, others procured in 1878, and some existing in an old collection which were taken from these mines a century ago, have all been studied with extreme care by his assistant, Dr. M. G. Lindström. All the analyses yield with atomic precision the formula,

$$\dot{Ca}\,\ddot{Si} + \dot{Ca}\,\dddot{S} + \dot{Ca}\,\ddot{C} + 14\,H_2O$$

Notwithstanding the extraordinary composition of this mineral, microscopical examination shews that it is a true species, and not a mixture. It appears to Nordenskiöld that the knowledge of the existence of a mineral with such a composition will be very important in studying the changes which take place in the paste of rocks, and he feels convinced that this mineral—to which he gives the name of Thaumasite from the Greek word signifying to astonish—will be found in other mines now that the attention of mineralogists is directed to it.

T. D.

The Keith Medal.—On the 3rd inst., at a meeting of the Royal Society of Edinburgh, the President, Professor Kelland, in presenting the Keith Medal which had been awarded by the Council to Professor Heddle, of St. Andrews, delivered the following address:—"Professor Heddle—I am here to-night to exemplify a remark which is often made, that to insure success in an address, such as I am about to deliver, the best way is to commit the charge of it to one absolutely ignorant of the subject. No false pride will then stand in the way of the best sources of information, nor will any undue admixture of half knowledge clog and darken the truth. For every particular contained in these remarks, then, I at once unhesitatingly acknowledge myself indebted to Professor Geikie. When I first became acquainted with this Society, forty years ago, there used to frequent our meetings men who had the reputation of being mineralogists rather than geologists—Lord Greenock, Allan, and perhaps Jameson himself. That race has now died out, and with them mineralogy, as a distinct science, has all but lain dormant amongst us. During the preceding quarter of a century that science had flourished nowhere more vigorously than in Edinburgh. Professor Jameson introduced the definiteness of system of the Freyberg School, and infused into his pupils such a love of minerals that numerous private cabinets were formed; while under his fostering care the University Museum grew into a large and admirable series. One of my first acts as Professor in the University was

to vote out of the Reid Fund, which had just come into our hands, a large sum (some thousands) to pay back moneys expended on minerals throughout a series of years preceding. During these years, Geology, as the science is now understood, hardly existed. For, as the nature and importance of the organic remains embedded in rocks became recognised, their enormous value in the elucidation of geological problems gradually drew observers away from the study of minerals. Consequently, as Palæontology increased, Mineralogy waned among us. To such an extent was the study of minerals neglected, that geologists, even of high reputation, could not distinguish many ordinary varieties. But, as a knowledge of rocks presupposes an acquaintance more or less extensive with minerals, the neglect of mineralogy reacted most disadvantageously on that domain of geology which deals with the composition and structure of rocks. The nomenclature of the rocks of Britain sank into a state of confusion, from which it is now only beginning to recover. To you, Professor Heddle, belongs the merit of having almost alone upheld the mineralogical reputation of your native country during these long years of depression. You have devoted your life to the study, and have made more analyses of minerals than any other observer in Britain. You have not contented yourself with determining their composition and their names; you have gone into almost every parish in the more mountainous regions, have searched them out in their native localities, and, by this means, have studied their geological relations, treasuring up evidences from which to reason regarding their origin and history. After thirty years of continuous work, you have communicated the results of your labours to this Society. For the first two of these papers on the Rhombohedral Carbonates and on the Feldspars, in which you have greatly extended our knowlege of pseudomorphic change among minerals, enunciating a law of the shrinkage so frequently resulting therefrom, the Society proposes now to express its gratitude to you. The value of your papers is undoubted. Through the kindness of Mr. Milne Home, I have been favoured with the sight of letters addressed to you by four eminent mineralogists, Dana of America, Rammelsberg of Berlin, Szabo of Buda-Pesth, and King of Queen's College, Galway. Szabo states that the notice of your paper on the Feldspars, which appeared in Groth's *Zeitschrift für Mineralogie*, greatly interests him, and makes him desirous of placing himself in direct communication with the author. Dana says, 'I have read your paper on the Feldspars, in the transactions of the Royal Society of Edinburgh, with great satisfaction. Your thorough method of work leads towards important results of great geological, as well as mineralogical value.'

"I have the satisfaction, in the name of the Council of this Society, of presenting you with the Keith Medal. It is hoped that this recognition of your labours will not be without encouragement to you in the arduous researches in which you are engaged."—*Nature*, Feb. 13, 1879.

Correspondence.

PERCYLITE.

SIR,—I beg to call your attention to some specimens of this rare mineral from a new locality, viz.—Mina San Rafael, Galeria al Norte, Bolivia, from which place I have found the above together with other interesting and, I think, new minerals. It is mostly in a massive state, but in small fissures and cavities are microscopic cubic crystals, transparent and of a fine blue color, the massive part, which is sometimes rather friable, gives the reactions of chlorine, lead, and copper, so I think there is but little doubt of its being Percylite.

Yours truly,

JAMES R. GREGORY.

STEELEITE.—Prof. How writes to say that the name of the new variety of mordenite described in the last number of the *Mineralogical Magazine* should be spelt as above, not *Steelite*, which does not bring out the reference to Mr. Steele, and he is sorry he did not write it Steeleite at first.

Obituary.

SIR F. M. WILLIAMS, BART., M.P. for the Borough of Truro, and a life-member of the Mineralogical Society, died suddenly at his residence at Heanton, in Devon, on Tuesday, September 3, 1878, aged 48 years. He was largely connected with the mining, smelting, and manufacturing interests of Cornwall.

"The many workmen in his employ lose not only a kind and considerate employer, but a true friend."

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